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ABSTRACT

This self-study program for the high-school level contains lessons in the following subjects: Plants and Photosynthesis; The Human Digestive System; Functions of the Blood; Human Circulation and Respiration; Reproduction of a Single Cell; Reproduction by Male and Female Cells; The Human Reproductive System; Genetics and Heredity; The Nervous System; and The Glandular System. Each lesson concludes with a Mastery Test to be completed by the student. (DB)

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ADVANCED
GENERAL EDUCATION PROGRAM

A HIGH SCHOOL SELF-STUDY PROGRAM

PLANTS AND PHOTOSYNTHESIS

LEVEL: III
UNIT: 3
LESSON: 1

AC014054

U.S. DEPARTMENT OF LABOR
MANPOWER ADMINISTRATION, JOB CORPS
NOVEMBER 1969

1

U.S. DEPARTMENT OF LABOR
MANPOWER ADMINISTRATION, JOB CORPS
NOVEMBER 1969

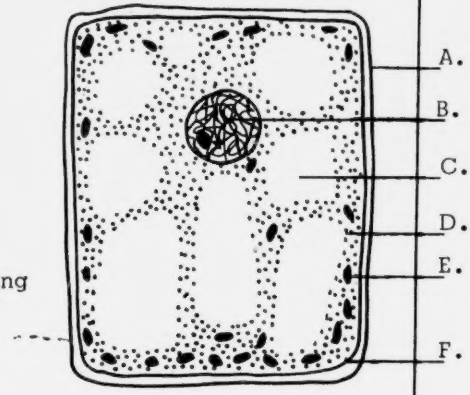
In this last science unit, you will learn about the ways that specific organ systems perform the life functions which characterize living things. For example, you have already learned that the functions of digestion, secretion, and reproduction are performed by all living things. Now you will learn the specific parts and functions of the different systems in the human body which specialize in the functions of digestion, secretion, and reproduction. Among other things, you will study how different foods are digested, how glands secrete substances which influence sexual characteristics, and how the male and female sex organs function in the process of reproduction.

Most of the sections in this unit deal with the structure and function of the human body. If you master the material in this unit you will have a better understanding of the many complex processes in your own body. You will also be able to understand important scientific and medical information when it is presented on television or radio, or in the newspapers. The ability to understand such information will allow you to apply the latest scientific findings to your own life, and thus increase your chances of being healthy and comfortable.

Time completed ______________

1. This unit will be concerned with plants, particularly, green plants. You will review material you have already learned about the structure of plant cells; and you will study the process by which most plant cells, unlike animal cells, manufacture their own food. NO RESPONSE REQUIRED	GO ON TO THE NEXT FRAME
2. REVIEW FRAME	
Chlorophyll* is a substance found in: ☐ most animal cells ☐ most plant cells ☐ plant and animal cells	most plant cells
Chlorophyll is a green pigment that is found in: ☐ the vacuoles ☐ the chloroplasts ☐ the chromatin	the chloroplasts
The function of chlorophyll is: ☐ to control the life functions of the cell ☐ associated with the cell's production of food ☐ connected with reproduction	associated with the cell's . . .
*Chlorophyll (klor-o-fill) is Greek for green leaf.	

3.	
In a previous lesson, you learned that generally the difference between plant and animal cells is the presence of chlorophyll. This green pigment which is necessary in the production of the plant's food is found in most green plants.* Also, some plants that do not appear green, such as the red-leaf maple, actually contain chlorophyll that is not readily visible because of other pigments in the cell.	
What are the other differences between plant and animal cells that you have learned?	
☐ Only plant cells have cell membranes.	
☐ Animal cells do not have cell walls.	Animal cells do not have cell walls.
☐ Animal cells contain larger vacuoles than plant cells.	
☐ Plant cells contain larger vacuoles than animal cells.	Plant cells contain larger . . .
☐ Only plant cells have centrioles.	
☐ Only animal cells have centrioles.	Only animal cells have centrioles.
*There are some molds that do not contain chlorophyll even though they have green pigment.	

4. LABEL the parts of the cell using the terms listed below: A. cell wall B. nucleus C. vacuole D. cytoplasm E. chloroplast containing chlorophyll F. cell membrane  The cell is: ☐ a plant cell ☐ an animal cell	 a plant cell
5. All chlorophyll-bearing plants can produce their own food. Can all plants produce their own food? ☐ yes ☐ no	no

6. In an earlier lesson, you studied the oxidation process through which the human body obtains energy. The chief source of ready energy used by the body in the oxidation process is: ☐ glucose ☐ fatty acids ☐ glycerine ☐ amino acids	glucose
Glucose is a: ☐ carbohydrate ☐ lipid ☐ protein	carbohydrate
In the process of oxidation, glucose reacts with: ☐ hydrogen ☐ nitrogen ☐ oxygen	oxygen
in order to: ☐ release energy ☐ trap energy	release energy
The waste products of the oxidation process are: ☐ carbon dioxide ☐ hydrogen ☐ oxygen ☐ water	carbon dioxide water
7. glucose + oxygen ⟶ energy + water + carbon dioxide The "equation" above: ☐ correctly states the oxidation process ☐ does not correctly state the oxidation process	correctly states the . . .

8.	
Oxidation is also carried on in plant cells in order to provide them with the energy they need to carry on the life functions.	
CHECK the items below that plant cells use to carry on the oxidation process:	
☐ glucose	glucose
☐ oxygen	oxygen
☐ fatty acids	
☐ glycerine	
☐ carbon dioxide	
What are the waste products of the energy-producing reaction that takes place in plant cells:	
☐ glucose	
☐ oxygen	
☐ fatty acids	
☐ glycerine	
☐ carbon dioxide	carbon dioxide
☐ water	water
Using the words listed below write a statement of the oxidation process as an equation:	
carbon dioxide energy glucose oxygen water	glucose + oxygen → energy + water + carbon dioxide

9. Your body obtains glucose by digesting the food you eat. When we say that some plants can produce their own food, we mean that these plants can manufacture their own glucose. Which plants produce glucose: ☐ plants with chlorophyll ☐ plants without chlorophyll	plants with chlorophyll
10. Knowing the end products of the oxidation process, what else would you suppose chlorophyll-bearing plants need in producing their own food? ☐ oxygen ☐ carbon dioxide ☐ water ☐ glucose You guess that plants would: ☐ need energy to produce their own food ☐ release energy when they produce their own food	carbon dioxide water need energy to produce their . . .

11. The energy plant cells use to produce their own food comes from sunlight.* Using the words listed below, write an equation to state the food-producing process that takes place in chlorophyll-bearing plant cells: sunlight glucose carbon dioxide oxygen water *Light from light bulbs can be an energy source for plants indoors.	sunlight + water + carbon dioxide → glucose + oxygen
12. This food producing process is called photosynthesis. Photosynthesis comes from the Greek word meaning "made with (the help of) light." Photosynthesis is a process that takes place: ☐ in all plant cells ☐ in all chlorophyll-bearing plant cells ☐ in all animal cells	in all chlorophyll-bearing . . .
13. MATCH the columns below: A. energy-producing reaction B. food producing reaction 1. _____ oxidation 2. _____ photosynthesis	A B

14.	
In photosynthesis, sunlight is usually the energy source that the plant uses to produce its food.	
carbon dioxide glucose oxygen water	
Use the words above to complete the statements below:	
In photosynthesis, plant cells use sunlight to put together ______________ and ______________.	carbon dioxide, water (any order)
The end products or the substances produced by the process of photosynthesis are ______________ and ______________.	oxygen glucose (or equivalent response)
15.	
What are the end products of the oxidation process:	
☐ energy	energy
☐ glucose	
☐ oxygen	
☐ carbon dioxide	carbon dioxide
☐ water	water
Are the end products of the oxidation process the same as the end products of photosynthetic process?	
☐ yes	
☐ no	no
LIST the end products of the photosynthetic process.	
______________	glucose
______________	oxygen

16.	
MATCH the equation with the process it represents:	
1. ______ carbon dioxide + water + energy → glucose + oxygen	B
2. ______ glucose + oxygen → energy + carbon dioxide + water	A
A. oxidation B. photosynthesis	
As far as materials used and materials produced, photosynthesis and respiration are: ☐ the same or almost the same ☐ almost exactly the reverse of one another	almost exactly the reverse . . .

17.	
MATCH the columns below:	
A. oxidation B. photosynthesis	
1. ______ is the energy-producing reaction that takes place in plant and animal cells	A
2. ______ is the food-producing reaction that takes place in cells that contain chlorophyll	B
3. ______ ends with carbon dioxide and water	A
4. ______ ends with oxygen and glucose	B
5. ______ begins with carbon dioxide and water	B
6. ______ begins with oxygen and glucose	A
7. ______ needs energy	B
8. ______ produces energy	A
18.	
Photosynthesis takes place in cells that: ☐ contain chlorophyll ☐ do not contain chlorophyll	contain chlorophyll
These cells are called chloroplasts. You know that chloro means ________________.	green
Do you know any other word containing plast? ________________	plastic
Plast means makes or shapes in Greek; in biology it names particles which make something be round, or colored, etc. Chloroplast means, makes it: ☐ plastic ☐ green ☐ a plant	green

19. Photosynthesis cannot take place without chlorophyll. Scientists do not understand fully how chlorophyll affects the food-producing process; however, they do know that this substance is necessary to convert light energy to chemical energy that can be used by the cell to manufacture glucose. Photosynthesis depends on a substance found in the: ☐ centrioles of a cell ☐ vacuoles of a cell ☐ chloroplasts	chloroplasts
20. Although photosynthesis cannot take place without chlorophyll, the chlorophyll is not used up in the process. Its presence is simply necessary for the reaction to take place. Chlorophyll is necessary to photosynthesis because it: ☐ helps convert light energy to chemical energy ☐ is a necessary end product of the process ☐ becomes a part of the glucose produced	helps convert light energy to . . .
21. Because chlorophyll converts light energy to chemical energy, photosynthesis: ☐ can take place ☐ cannot take place	can take place

22.	
A substance which causes a chemical reaction but is not itself used up or changed by the reaction is called a catalyst.	
Is chlorophyll a catalyst?	
☐ yes ☐ no	yes
Do cells that contain chloroplasts contain a catalyst?	
☐ yes ☐ no	yes
23.	
Chlorophyll is a catalyst in the photosynthetic process.	
What statement(s) below is/are true?	
☐ Without chlorophyll, photosynthesis could not take place.	. . . could not take place.
☐ Without chlorophyll, photosynthesis could not take place as quickly as it can with the catalyst.	
☐ Without chlorophyll, the end products of photosynthesis would be different.	
☐ Chlorophyll is produced by the reaction.	
☐ Chlorophyll is necessary to but not changed by the reaction that takes place.	Chlorophyll is necessary to . . . .

24.	
A catalyst:	
☐ can cause a reaction to take place	can cause a reaction to take place
☐ has no effect on any reaction	
☐ is changed by the reaction that takes place	
☐ is not changed by the reaction that takes place	is not changed by the reaction . . .
Chorophyll is:	
☐ a catalyst	a catalyst
☐ not a catalyst	
The catalyst necessary for photosynthesis to take place is found in:	
☐ the chloroplasts	the chloroplasts
☐ the centrioles	
☐ the vacuoles	
☐ the cell walls	

25. Cells use photosynthetic glucose as an energy source for their life funtions. Photosynthesis can only take place in the presence of light; thus, plant cells produce more glucose than they can immediately use and store the extra glucose for the energy needed in the dark-hours of the day. You would guess that this extra glucose is stored in the: ☐ vacuoles ☐ centrioles ☐ cell wall ☐ chloroplasts Glucose is a: ☐ carbohydrate ☐ lipid ☐ protein	vacuoles carbohydrate
26. Glucose is a very simple form of carbohydrate. In order to store glucose, plants convert it to a more complex form called starch. Starch: ☐ can be found in a plant cell's vacuoles ☐ cannot be found in a plant cell's vacuoles	can be found in a plant . . .
27. When photosynthesis cannot take place on a very cloudy day, plants reconvert their stored starch to glucose. Starch is a: ☐ carbohydrate ☐ lipid ☐ protein	carbohydrate

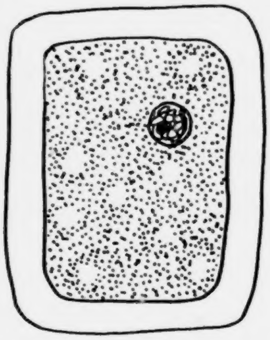
28. An end product of photosynthesis is: ☐ glucose ☐ starch which is stored for future use as: ☐ glucose ☐ starch	glucose starch
29. PREVIEW FRAME In an earlier lesson you learned that certain cells specialize in certain life functions; cells similar in function and appearance are grouped together to form a tissue. You also learned that a group of tissues performing related activities is called an organ; organs, according to their function, are parts of systems. The cells of plants, and animals are organized into tissues, organs, and systems. Since there are thousands of different plant types, however, we will limit our discussion to a typical "seed plant," which is representative of the more complex plant types. We will begin this section with a discussion of plant tissues. NO RESPONSE REQUIRED	GO ON TO THE NEXT FRAME

30. The tissue which carries out the food-producing process in plants is called photosynthetic tissue. The cells of photosynthetic tissue: ☐ contain chloroplasts ☐ do not contain chloroplasts	contain chloroplasts
31. The tissue that specializes in the storage of food and water is called parenchyma.* You could guess that the cells of the parenchyma: ☐ contain large vacuoles ☐ do not contain large vacuoles *Parenchyma (paren-ky-ma), from Greek chyma (pour water) en(in) para (along side as parallel or parents).	contain large vacuoles

32.

The cells that specialize in the support of the plant form a tissue called supporting tissue.

LOOK at the drawing below which represents a typical cell in sclerenchyma* tissue.



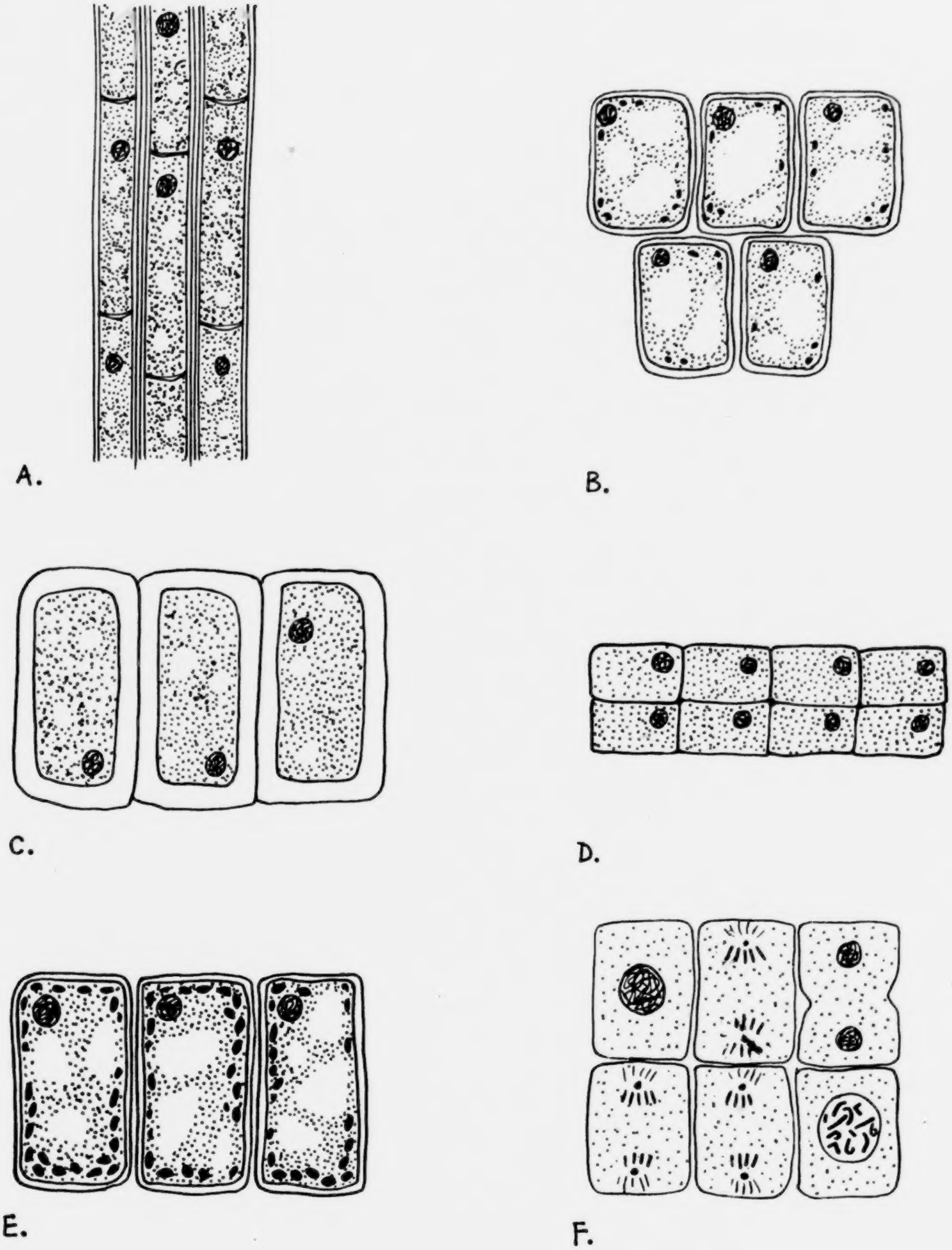
From the drawing above, it is obvious that the supporting tissue:

☐ contains cells with thick cell walls
☐ contains cells with thin cell walls
☐ contains cells with thick cell membranes
☐ contains cells with thin cell membranes

*Sclerenchyma means stiff, from the Greek for (poured in) hardening.

. . . thick cell walls

PANEL 1



33.

In a previous lesson you learned that cells forming epidermal* tissue are packed closed together. These cells secrete substances and protect the organism. Plants also have epidermal tissue. In plants, the epidermal tissue also specializes in absorbing substances that the plant nees.

REFER TO PANEL 1

The panel shows the different plant tissues. Which drawing represents epidermal tissue?

- ☐ A
- ☐ B
- ☐ C
- ☐ D
- ☐ E
- ☐ F

*Epi-der-mal, the skin or covering.

D

34.

The tissue in plants that specializes in conducting food material and water to different parts is called conducting tissue. The cells of this tissue are long and tube shaped.

Which drawing represents conducting tissue?

- ☐ A
- ☐ B
- ☐ C
- ☐ D
- ☐ E
- ☐ F

A

35. Unlike the human body, many plants contain tissue that continues to grow during the entire life of the organism. This tissue is called the growth tissue. The cells of the growth tissue are reproducing rapidly, and thus their nuclei have a distinctive appearance.* Which drawing would you guess represents the growth tissue? ☐ A ☐ B ☐ C ☐ D ☐ E ☐ F *You will learn more about the reproduction of cells in a later lesson.	F
36. REFER TO PANEL 1 The structure of plant cells specializing in a specific function: ☐ is different from tissue to tissue ☐ is the same for all tissues	is the same for all tissues

37.

REFER TO PANEL 1

The special functions performed by plant tissue in Panel 1 are:

photosynthesis
support
storage
growth
conduction
protection and absorption

Study the structure of the cells in the tissues drawn on Panel 1. MATCH each tissue in Panel 1 to the function above in which it specializes.

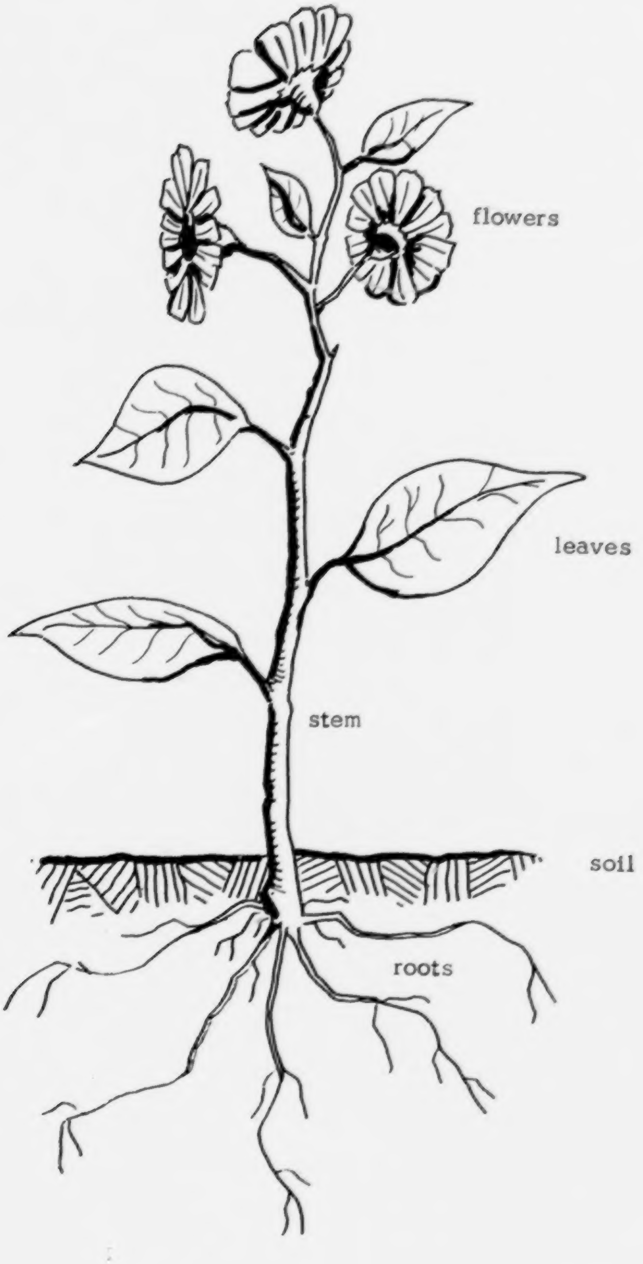
_____	photosynthesis	E
_____	support	C
_____	storage	B
_____	growth	F
_____	conduction	A
_____	protection and absorption	D

38.

We will now see how these tissues form organs in a typical plant.

NO RESPONSE REQUIRED	GO ON TO THE NEXT FRAME

PANEL 2


flowers
leaves
stem
soil
roots

39. REFER TO PANEL 2 The panel shows a typical seed plant. Plants of this nature are made up of four kinds of organs. These are:	
______________	roots
______________	stem
______________	leaves
______________	flowers
	(any order)
40. **REFER TO PANEL 2** The roots of a seed plant usually grow beneath the surface of the soil. Here the roots absorb water and dissolved minerals from the soil and conduct them into the stem. The roots may also be a storage place for plant food. Finally, the roots hold the plant in place. Which of the following functions do the roots perform?	
☐ manufacture of food	
☐ transportation of food to other parts of the plant	transportation of food to . . .
☐ securing raw material (water, mineral)	securing raw material . . .
☐ storing food	storing food
☐ anchoring the plant in place	anchoring the plant in place

41.	
REFER TO PANEL 2	
Which organs of the seed plant obtains water and minerals directly from the soil? ______________	the roots
These organs:	
☐ also may store food	also may store food
☐ also transport material up to the stem	also transport material up to . . .
☐ also anchor the plant in place	also anchor the plant in place
☐ also manufactures food	
42. **REFER TO PANEL 2**	
What part of the seed plant obtains water and minerals from the soil and anchors the plant in the soil?	
☐ the leaves	
☐ the flowers	
☐ the roots	the roots
☐ the stem	
43.	
REFER TO PANEL 2	
The stem of the seed plant:	
☐ is connected to the roots	is connected to the roots
☐ is not connected to the roots	
☐ is connected to the leaves	is connected to the leaves
☐ is not connected to the leaves	
☐ is connected to the flowers	is connected to the flowers
☐ is not connected to the flowers	
The stem is continuous with:	
☐ all the other organs of the seed plant	all the other organs of the . . .
☐ some of the other organs of the seed plant	

44. **REFER TO PANEL 2** One function of the stem is transporting materials to and from other organs of the seed plant with which it is continuous. The stem transports materials to and from the: ☐ roots ☐ leaves ☐ flowers	roots leaves flowers
45. **REFER TO PANEL 2** The cells of stems contain **large vacuoles*** and thick cell walls. You would suppose, therefore, that the primary activities of this organ include: ☐ storage ☐ supporting stiffness ☐ irritability ☐ secretion ☐ the manufacture of food *Vacuoles are spaces holding water or air between tissues.	storage supporting stiffness
46. **REFER TO PANEL 2** The organ which contain most of the chlorophyll of the plant are the leaves. From this fact you might deduce that the leaves are primarily responsible for: ☐ reproduction ☐ photosynthesis ☐ obtaining water and minerals directly from the soil The leaves are wider and flatter than other plant organs and so are more exposed to air and light. The process of ________________ requires a catalyst called ________________, which is in the leaf's ______________ cell.	photosynthesis photosynthesis chlorophyll, chloroplast

47. The organ of the seed plant responsible for the manufacture of food is the: ☐ stem ☐ leaf ☐ flower ☐ root	leaf
48. We call certain plants seed plants because they carry on their species by means of seeds which are produced in the flower. The flower is an organ of: ☐ reproduction ☐ excretion ☐ digestion	reproduction
49. The flowers of a plant are highly specialized for the process of reproduction. The basic product of the flowers is: ☐ food ☐ new stems ☐ seeds	seeds

50.

MATCH the organs of the seed plant to the functions they perform.

A. root	1. _____ anchors plant in the soil	A
B. stem	2. _____ manufactures food	C
C. leaf	3. _____ supports the leaves and flowers	B
D. flower		
	4. _____ production of seeds	D
	5. _____ transports materials back and forth from all the plant parts	B
	6. _____ absorbs water and minerals from the soil	A

51.

The flowers are the reproductive organs of the seed plant and produce seeds.

The other organs of the plant are concerned with securing water, air and minerals, making, carrying and storing food; and growing. These organs are called the vegetative organs or non-reproductive organs.

Next to each plant organ listed below WRITE R to indicate reproductive organ or V to indicate vegetative organ.

_____ roots	V
_____ stem	V
_____ flowers	R
_____ leaves	V

52. The roots, stem, and leaves of a seed plant are called the: ☐ vegetative organs ☐ reproductive organs These parts are involved in: ☐ producing seeds ☐ the manufacture and use of food	vegetative organs the manufacture and use of food
53. CHECK the organs that carry out the vegetative activities of the seed plant: ☐ root ☐ flowers ☐ stem ☐ leaves	root stem leaves

54.

The 4 main organs of a seed plant are:

____

____

____

____

root

stem

leaf

flower

Time completed _______________

YOU HAVE NOW FINISHED THE FIRST PART OF THIS LESSON. WRITE DOWN THE TIME. THEN, AFTER YOU HAVE REVIEWED THE MAIN IDEAS IN THE FOLLOWING SUMMARY, TAKE THE MASTERY TEST AT THE END OF THE BOOKLET.

DIFFERENCES BETWEEN PLANT AND ANIMAL CELLS	1. Most plant cells contain a green pigment called chlorophyll found in the chloroplasts, 2. cell walls and, 3. larger vacuoles than animal cells. 4. Plant cells do not contain centrioles.
ALL PLANTS THAT CONTAIN CHLOROPHYLL CAN PRODUCE THEIR OWN FOOD.	The food produced is a carbohydrate - glucose. Glucose is stored as starch. Starch is also a carbohydrate.
THE PROCESS BY WHICH PLANTS CONTAINING CHLOROPHYLL MANUFACTURE THEIR OWN FOOD	is called photosynthesis. Light energy is necessary for photosynthesis to take place. The light energy is converted to chemical energy by the chlorophyll. Chlorophyll is a catalyst.
A CATALYST	A catalyst is a substance which can cause a reaction to take place, but is not itself changed by the reaction that takes place.
THE PROCESS OF OXIDATION	glucose + oxygen ⟶ carbon dioxide + water + energy
THE PROCESS OF PHOTOSYNTHESIS	carbon dioxide + water + energy ⟶ glucose + oxygen
PLANTS, LIKE ANIMALS, ARE ORGANIZED INTO TISSUES, ORGANS, AND SYSTEMS.	
PLANT TISSUES	Photosynthetic tissue - cells contain chloroplasts and specialize in producing food. Parenchyma - cells contain large vacuoles and specialize in storing necessary substances (food and water).

PLANT TISSUES (cont'd.)	Supporting tissue - cells have thick cell walls and specialize in supporting the plant. Epidermal tissue - cells are closely packed together to protect the organism. These cells specialize in secretion and absorption. Conducting tissue - cells are long and tube shaped and specialize in conducting food material and water to different parts of the plant. Growth tissue - cells are continually reproducing during which their nuclei have a distinctive appearance.
A TYPICAL SEED PLANT CONTAINS 4 MAJOR TYPES OF ORGANS:	Roots are usually found beneath the soil. They absorb water and dissolved materials from the soil and conduct them to the stem. The roots also store the plant's food and help to keep the plant in place. Stems connect the roots with the flowers and leaves. Their main function is to transport food materials and water to other plant parts. The stems also store food and water and support the plant. Leaves specialize in producing the plant's food. Flowers are the organs of reproduction. They produce seeds from which a new plant can develop.
THE VEGETATIVE ORGANS OF A SEED PLANT ARE THE LEAVES, ROOTS, AND STEMS.	
THE REPRODUCTIVE ORGANS OF A SEED PLANT ARE THE FLOWERS.	

MASTERY TEST

Time started ________________

1. A. The end products of the oxidation process are:

   a. ☐ carbon dioxide
   b. ☐ water
   c. ☐ energy
   d. ☐ glucose
   e. ☐ oxygen

   B. The end products of the photosynthetic process are:

   a. ☐ carbon dioxide
   b. ☐ energy
   c. ☐ glucose
   d. ☐ oxygen
   e. ☐ water

2. The catalyst necessary for photosynthesis to take place is found in:

   a. ☐ the chloroplasts of a cell
   b. ☐ the vacuoles of a cell
   c. ☐ the cell walls of a cell
   d. ☐ the centrioles of a cell

3. The food manufactured by the photosynthetic process is stored as:

   a. ☐ glucose
   b. ☐ starch
   c. ☐ lipids
   d. ☐ protein

4. MATCH the columns below:

1. conducting tissue
2. parenchyma (storage) tissue
3. photosynthetic tissue
4. supporting tissue

A. _____ cells are long and tube shaped

B. _____ cells walls contain chloroplasts

C. _____ cell deposits of starch

D. _____ cells have thick cell walls

5. A. Of the four major organs of a seed plant, which is reproductive?

   a. ☐ flower
   b. ☐ leaf
   c. ☐ root
   d. ☐ stem

   B. The vegetative organs of a seed plant are the:

   a. ☐ flowers
   b. ☐ leaves
   c. ☐ roots
   d. ☐ stems

Time completed ______________

WHEN YOU HAVE FINISHED THIS TEST, WRITE DOWN THE TIME. THEN TAKE THE LESSON TO YOUR INSTRUCTOR OR HIS ASSISTANT FOR CHECKING. WAIT UNTIL THE LESSON IS APPROVED BEFORE GOING ON TO THE NEXT LESSON.

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A HIGH SCHOOL SELF-STUDY PROGRAM

THE HUMAN DIGESTIVE SYSTEM
LEVEL: III
UNIT: 3
LESSON: 2

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MANPOWER ADMINISTRATION, JOB CORPS
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1.

PREVIEW FRAME

You have already been introduced to such terms as ingestion, digestion, absorption, and assimilation. These terms describe some of the steps involved in our body's utilization of the food we eat.

As you know, before food can be used by the body, it must be broken down to simple forms. This function is carried out by the digestive system. We briefly discussed the organs of the digestive system in a previous lesson. Now, we will describe these organs and their activities in greater detail. At the end of this lesson, you will have a better understanding of how food is actually broken down in the body.

NO RESPONSE REQUIRED

GO ON TO THE NEXT FRAME

2.

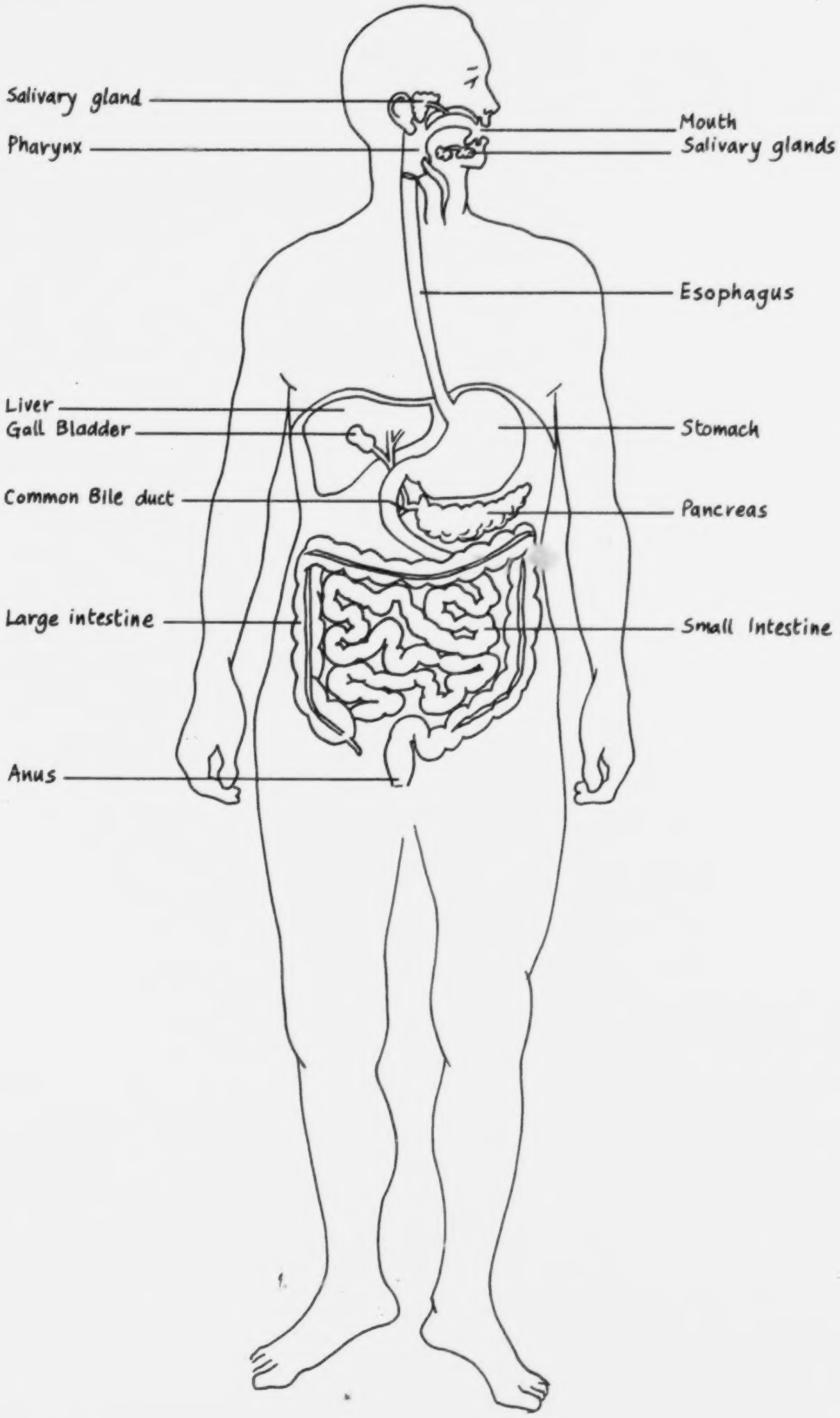
REVIEW FRAME

MATCH the columns below:

A. digestion	1. _____ breaking down of food into simple chemical compounds that can be used by the body	1. A
B. excretion	2. _____ elimination of indigestible food and waste products	2. B
C. secretion	3. _____ production of special chemicals that aid and control life functions	3. C

2. Digestion is the process of breaking down food. Food, in order to be used by the body in energy-producing reactions, must be changed physically (chopped and crushed into small pieces) and chemically (into simpler compounds). Are your teeth used in the process of digestion? ☐ yes ☐ no	yes
3. Even before you eat, your mouth often begins to "water." This "water" is a fluid called saliva. Saliva: ☐ is brought into your mouth with food ☐ is produced within your mouth	is produced within your mouth
4. About 99% of saliva is water which aids chewing by softening and dissolving the pieces of food to make them easier to swallow. Saliva also contains a substance which chemically affects some of the food you eat. Saliva is: ☐ a secretion which aids and controls digestion ☐ a secretion which has no effect on a life function ☐ not secreted by the body	. . . controls digestion

PANEL 1


Salivary gland
Mouth
Pharynx
Salivary glands
Esophagus
Liver
Gall Bladder
Stomach
Common Bile duct
Pancreas
Large intestine
Small Intestine
Anus

5.	
Saliva is a fluid that is secreted by organs that are found in the lining of the mouth. Organs that produce secretions are called glands.	
REFER TO PANEL 1	
The panel shows parts of the digestive system.	
The fluid in your mouth is secreted by which structures indicated on the panel ? ______________	salivary glands
6.	
A gland is:	
☐ any part of the digestive system	
☐ an organ that produces only saliva	
☐ an organ that produces secretions	an organ that produces . . .
The fluid in your mouth:	
☐ is produced by the salivary glands	is produced by the salivary . . .
☐ is only water	
☐ is not a secretion	
Saliva:	
☐ is a secretion	is a secretion
☐ is only produced when you eat	
☐ is produced by glands	is produced by glands
☐ is only water	
☐ chemically affects some of the food you eat	chemically affects . . .

7. PREVIEW FRAME We said that saliva chemically affects some of the food you eat. Let's review what you know about the three main types of food: carbohydrates, lipids, and proteins, before we discuss what food is chemically affected by saliva. NO RESPONSE REQUIRED	GO ON TO THE NEXT FRAME
8. Glucose, the food substance produced in photosynthesis, is stored in plants as: ☐ lipids ☐ protein ☐ starch Starch is: ☐ a carbohydrate ☐ a lipid ☐ a protein	starch a carbohydrate
9. There are two main forms of carbohydrates - they are sugars and starches. CHECK the foods below containing large quantities of starch: ☐ flour ☐ potatoes ☐ rice ☐ brown sugar ☐ glucose ☐ bacon ☐ lettuce	flour potatoes rice

10. Potatoes, rice, and flour contain a food substance that is in the same category as sugar. These foods are: ☐ proteins ☐ carbohydrates ☐ lipids	carbohydrates
11. Saliva is a fluid composed of water and a chemical compound which initiates the breakdown of starch into simpler substances. CHECK the food(s) below that would be affected by the chemical compound in saliva: ☐ a sweet potato ☐ ham ☐ brown sugar ☐ butter	a sweet potato
12. REVIEW FRAME A catalyst can: ☐ initiate a specific chemical reaction ☐ have no effect on a specific substance ☐ be changed by the chemical reaction ☐ not be changed by the chemical reaction	initiate a specific chemical . . . not be changed by the . . .

13. The secretion of the salivary glands, saliva, is composed mostly of water. The secretion also contains a substance that initiates, but is not itself changed by, the chemical digestion of starch. The secretion of the salivary glands: ☐ contains a catalyst ☐ does not contain a catalyst	contains a catalyst
14. A catalyst that is produced by the body is called an enzyme. Saliva: ☐ contains an enzyme ☐ does not contain an enzyme Saliva is a direct product of the life function of: ☐ excretion ☐ respiration ☐ secretion ☐ digestion	contains an enzyme digestion
15. An enzyme is: ☐ a direct product of secretion ☐ a direct product of digestion ☐ a catalyst ☐ not a catalyst ☐ produced within the body ☐ produced outside the body	a direct product of digestion a catalyst produced within the body

16. The enzyme that saliva contains is called ptyalin.* Pytalin breaks down: ☐ proteins ☐ sugars ☐ starches ☐ lipids Ptyalin: ☐ is secreted by the salivary glands ☐ is not secreted by the salivary glands	starches is secreted by the . . .
17. CHECK the statements below that describe ptyalin. ☐ It is a type of carbohydrate. ☐ It is an enzyme. ☐ It helps digest sugars. ☐ It helps digest starches. ☐ It is produced in the salivary glands. ☐ It is ingested with food that is eaten.	It is an enzyme. It helps digest starches. It is produced in the salivary . . .
18. The salivary glands: ☐ secrete an enzyme ☐ produce a catalyst that initiates the breakdown of protein ☐ aid digestion ☐ control the life function of excretion *Ptyalin (tie-al-in) is Greek for saliva.	secrete an enzyme aid digestion

19.	
REFER TO PANEL 1	
When you swallow, food passes from the back of the mouth to a common passageway for food and air in the throat. The muscular movements in swallowing prevent food from entering the air passages to the lungs.* Thus, the food enters a second tube, about 10 inches long in the adult, which leads to a J-shaped sac near the mid portion of the body.	
The tube that is a common passageway for food and air is called the ________________.	pharynx
The tube that carries food from the pharynx to a J-shaped sac near the mid portion of the body is called the ________________.	esophagus
The J-shaped sac is called the ________________.	stomach
20.	
REFER TO PANEL 1 only if necessary	
Leaving the mouth, food first enters:	
☐ the stomach ☐ the esophagus ☐ the pharynx ☐ the passageway to the lungs	the pharynx
Food in the esophagus:	
☐ has not been mixed with saliva ☐ is already mixed with saliva ☐ has usually been chewed ☐ has not yet been chewed	is already mixed . . . has usually been chewed
Food passes through the esophagus:	
☐ on its way to the pharynx ☐ on its way from the pharynx ☐ on its way to the stomach	on its way from the pharynx on its way to the stomach

*Sometimes a little food slips into the air passage and chokes you. Your coughing is a muscular reflex action to clear the air passage.

21.	
Like the mouth, the lining of the stomach also contains glands that produce a secretion. This secretion initiates the chemical breakdown of proteins.	
Does the secretion that mixes with the food in the mouth and the secretion that mixes with food in the stomach digest the same type of food?	
☐ yes	
☐ no	no
What food is digested by ptyalin?	
☐ sugar	
☐ starch	starch
☐ proteins	
☐ lipids	
The digestion of what food is initiated by the secretion in the stomach?	
☐ potatoes	
☐ corn	
☐ hamburger	hamburger
☐ candy	
22.	
DO NOT REFER TO THE PANEL	
NUMBER the following parts of the digestive system in the order that food passes through them:	
_____ esophagus	3
_____ mouth	1
_____ stomach	4
_____ pharynx	2

23.	
The secretion that initiates the chemical breakdown of protein is produced by the gastric glands and is called gastric juice.	
The gastric glands are located in:	
☐ the lining of the mouth ☐ the lining of the stomach ☐ next to the salivary glands ☐ in the stomach, esophagus and pharynx	the lining of the stomach
MATCH the terms to their descriptions by writing one or more letters in each blank:	
A. gastric juice B. saliva	
1. _____ helps to digest food	1. A, B
2. _____ starts to work in the mouth	2. B
3. _____ starts to work in the stomach	3. A
24.	
Like saliva, gastric juice is composed of more than one substance.	
One of the substances of gastric juice helps the enzyme dissolved in it to digest protein, but, at the same time, this same substance inhibits the action of ptyalin.	
Saliva and gastric juice are:	
☐ the same substance ☐ different substances	different substances
The enzyme in saliva and the enzyme in gastric juice are:	
☐ the same ☐ different	different

25. A large part of gastric juice is a fluid called hydrochloric acid; the enzyme of gastric juice is called pepsin.*	
Hydrochloric acid aids the digestion of: ☐ sugars ☐ starches ☐ proteins ☐ lipids	proteins
but inhibits the action of: ☐ pepsin ☐ ptyalin	ptyalin
Saliva is composed of: ☐ water ☐ ptyalin ☐ hydrochloric acid ☐ pepsin	water ptyalin
Hydrochloric acid acts in the: ☐ esophagus ☐ mouth ☐ stomach	stomach
26. The major components of gastric juice are: ☐ carbohydrate ☐ hydrochloric acid ☐ pepsin ☐ ptyalin ☐ saliva ☐ starch ☐ protein	hydrochloric acid pepsin
*Pepsin is the Greek word for digestion.	

27.

COMPLETE the following table by CHECKING the appropriate boxes:

	Pepsin	Ptyalin	Pepsin	Ptyalin
active in breaking down starches	☐	☐	☐	☒
active in breaking down protein	☐	☐	☒	☐
especially active in the stomach	☐	☐	☒	☐
especially active in the mouth	☐	☐	☐	☒
is an enzyme	☐	☐	☒	☒
found mixed with hydrochloric acid	☐	☐	☒	☐
produced by the salivary glands	☐	☐	☐	☒
produced by the gastric glands	☐	☐	☒	☐

28. REFER TO PANEL 1 After 3 to 5 hours, the food in the stomach is in liquid form and ready to continue its passage through the rest of the digestive system. From the stomach, the food enters a series of tubes that eventually lead to the place at which undigested food and waste products are eliminated from the body. The first tube or small intestine, is packed close together and makes many twists and turns as it goes from the stomach to the lower part of the digestive system. Stretched out, this intestine has an average length of about 20 feet. The second intestinal tube makes only 2 turns. Stretched out, this tube has an average length of about 5 feet.	
The tube with the larger diameter is: ☐ longer than the tube with the smaller diameter ☐ shorter than the tube with the smaller diameter	shorter than the tube . . .
After 3 to 5 hours, the food leaves the stomach in: ☐ gaseous form ☐ liquid form ☐ solid form	liquid form
and enters the tube with: ☐ the smaller diameter ☐ the larger diameter	the smaller diameter
Undigested food leaves the body at the end of the tube with: ☐ the smaller diameter ☐ the larger diameter	the larger diameter

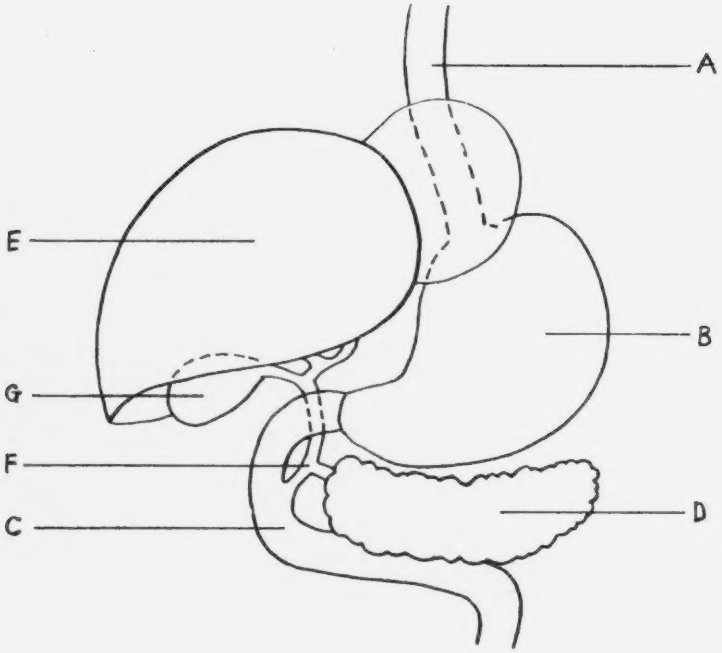
29. The tube that has a smaller diameter and is about 20 feet long is called the small intestine. The tube that has a larger diameter and is only about 5 feet long is called the large intestine. The end point of the large intestine, at which undigested food leaves the body, is called the anus. DO NOT REFER TO THE PANEL LIST the structures through which food passes on its way through the body. INCLUDE the stomach, mouth, esophagus, pharynx, and the three structures you have just learned in the order that food passes through them.	
1st. ____________	mouth
2nd. ____________	pharynx
3rd. ____________	esophagus
4th. ____________	stomach
5th. ____________	small intestine
6th. ____________	large intestine
7th. ____________	anus
30. DO NOT REFER TO THE PANEL Food passes through the:	
☐ large intestine before the small intestine ☐ small intestine before the large intestine	small intestine before . . .
The anus is located at the end of the:	
☐ large intestine ☐ small intestine ☐ stomach	large intestine

31. PREVIEW FRAME You will now learn about two more glands that lie near the stomach. Food does not pass through these glands to be digested. Nevertheless, these glands are important to the digestive system. One of these glands lies under the stomach. It is long and oval shaped and partially hidden from a front view by the stomach. The other gland has two main parts or lobes. It is the largest gland in the body (average weight is about 3.5 pounds); most of the gland lies to the right of the stomach. NO RESPONSE REQUIRED	GO ON TO THE NEXT FRAME

32.	
The two structures just described: ☐ produce secretions ☐ do not produce secretions	produce secretions
REFER TO PANEL 2 Panel 2 shows an enlarged drawing of the structures in the mid area of the body. The gland lying beneath the stomach and the gland lying to the right of the stomach perform several activities in the body.* Both of these glands, however, also secrete substances that aid digestion. The gland lying beneath the stomach is called the pancreas. The gland lying to the right of the stomach is called the liver. Which gland is the largest in the body? ☐ liver ☐ pancreas	liver
The pancreas is the gland: ☐ through which food passes on its way to the small intestine ☐ near the stomach, that has no part in the digestive process ☐ to which arrow D is pointing	to which arrow D is pointing

*You will learn about these activities later in the lesson and in subsequent lessons.

PANEL 2



33.

REFER TO PANEL 2

The panel shows a small tube, a duct, leading from the liver and a shorter duct leading from the pancreas. The panel shows these two ducts coming together before they enter:

- ☐ the small intestine
- ☐ the large intestine
- ☐ the stomach
- ☐ the liver
- ☐ the pancreas

the small intestine

34.

The secretion produced by the liver is called bile.

The secretion produced by the pancreas is called pancreatic juice.

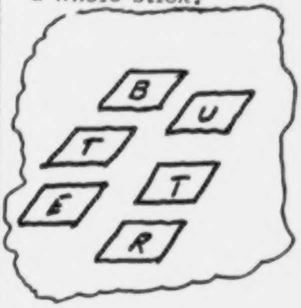
REFER TO PANEL 2 and MATCH the columns below:

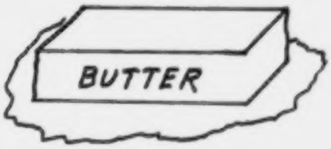
D.	the structure indicated by arrow D	1.	_____	where bile is produced	1. E
E.	the structure indicated by arrow E	2.	_____	where pancreatic juice is produced	2. D
F.	the structure indicated by arrow F	3.	_____	where bile and pancreatic juice come together before entering the small intestine	3. F

35.

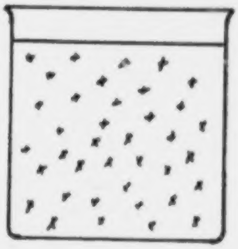
Pancreatic juice secreted by the pancreas has enzymes that help digest carbohydrates, proteins, and lipids.

Liver bile has no enzymes and acts only on lipids (fats) by breaking them into smaller particles. As you know, small pats of butter melt more easily and quickly than a whole stick.





Liver bile breaks lipids into smaller particles so enzymes can digest them more easily and quickly. When broken into small particles, the lipids float throughout the liquified food in the small intestine. Small particles floating throughout a liquid have been emulsified. An emulsion is a liquid with small particles floating in it.



NO RESPONSE REQUIRED

GO ON TO THE NEXT FRAME

36.	
The secretion produced by the liver:	
☐ emulsifies fats	emulsifies fats
☐ is an enzyme that acts on lipids	
☐ aids the digestion of carbohydrates, lipids, and proteins	
The secretion produced by the pancreas:	
☐ is not an enzyme	
☐ chemically affects carbohydrates, lipids, and proteins	chemically affects . . .
☐ emulsifies lipids	
Both bile and pancreatic juice help digest food in:	
☐ the stomach	
☐ the small intestine	the small intestine
☐ the pancreas	
☐ the liver	
CHECK the kinds of food that are digested in the small intestine:	
☐ starches	starches
☐ sugars	sugars
☐ proteins	proteins
☐ lipids	lipids

37.	
The name of the common duct that causes the secretions of the liver and the pancreas to the small intestine is the common bile duct.	
REFER TO PANEL 2	
The common bile duct is indicated by arrow F.	
The common bile duct carries:	
☐ only bile ☐ bile, pepsin, ptyalin, and pancreatic juice ☐ bile, gastric juice, pancreatic juice, and saliva ☐ bile and pancreatic juice	bile and pancreatic juice
from the:	
☐ liver ☐ pancreas ☐ both of the above	both of the above
to the:	
☐ stomach ☐ small intestine ☐ large intestine	small intestine
38.	
Some of the liver's secretion does not go directly to the small intestine but is stored in a small sac near the liver (SEE arrow G, PANEL 2).	
Is an enzyme stored in the small sac indicated by arrow G?	
☐ yes ☐ no	no

39. The sac that stores some of the liver's secretion for future use is called the gall bladder. The gall bladder is the storage place for: ☐ pancreatic juice ☐ gastric juice ☐ bile	bile

40.

REFER TO PANEL 2 and MATCH the columns below:

Arrow A	1. _____ carries bile and pancreatic juice to the small intestine	1. F
Arrow B	2. _____ carries food from the pharynx	2. A
Arrow C	3. _____ contains the glands that produce gastric juice	3. B
Arrow D	4. _____ produces bile	4. E
Arrow E	5. _____ produces pancreatic juice	5. D
Arrow F	6. _____ stores bile	6. G
Arrow G	7. _____ where bile and pancreatic juice digest food	7. C

41.

Glands in the lining of the small intestine also produce a secretion that aids digestion.

This secretion of glands in the small intestine's lining contains enzymes that break down carbohydrates, lipids, and proteins.

In that it contains enzymes which act on carbohydrates, lipids, and proteins, the secretion from glands in the lining of the small intestine is similar to:

☐ pancreatic juice
☐ gastric juice
☐ saliva
☐ bile

pancreatic juice

42.

The secretion produced in the lining of the small intestine that acts on carbohydrates, lipids, and proteins is called intestinal juice.

Intestinal juice:

☐ contains enzymes
☐ does not contain enzymes
☐ contains bile
☐ contains saliva

contains enzymes

43.

CHECK the appropriate boxes in the chart below:

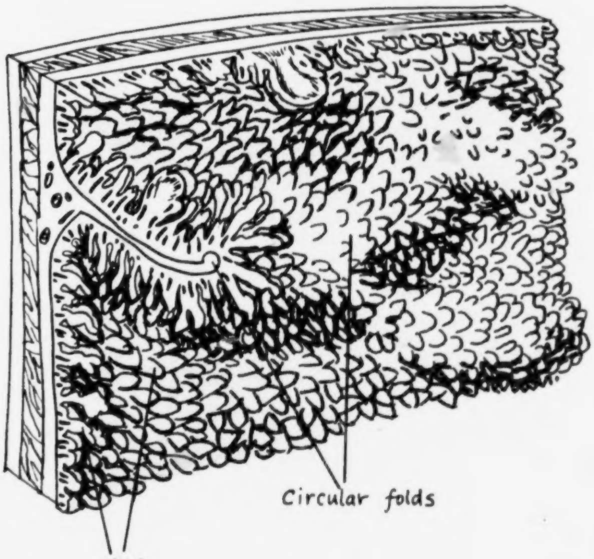
	Breaks down into:							
	lipids	proteins	starches	sugar	lipids	proteins	starches	sugar
saliva (ptyalin)	☐	☐	☐	☐	☐	☐	☒	☐
gastric juice (hydrochloric acid and pepsin)	☐	☐	☐	☐	☐	☒	☐	☐
bile	☐	☐	☐	☐	☒	☐	☐	☐
pancreatic juice	☐	☐	☐	☐	☒	☒	☒	☒
intestinal juice	☐	☐	☐	☐	☒	☒	☒	☒

44.

REVIEW FRAME

In a previous lesson you learned that in order for your body to use the food you eat, it breaks proteins down to:	
☐ amino acids ☐ fatty acids ☐ glucose ☐ glycerine	amino acids
and carbohydrates down to:	
☐ amino acids ☐ fatty acids ☐ glucose ☐ glycerine	glucose
and lipids down to:	
☐ amino acids ☐ fatty acids ☐ glucose ☐ glycerine	fatty acids glycerine

PANEL 3


Circular folds
Villi

45. The breakdown of food begins in the mouth and is increased in the stomach. But it is not until it is in the small intestine that food is finally broken down into the simpler compounds that can be absorbed into the blood stream. Digested food is taken into the blood stream in what forms ? ☐ emulsified lipids ☐ fatty acids ☐ starches ☐ glucose ☐ complex proteins ☐ amino acids ☐ glycerol	fatty acids glucose amino acids glycerol
46. Digested food is absorbed into the blood stream through the lining of the small intestine. The lining of the small intestine is made up of tiny fingerlike projections, which are arranged in many circular folds. REFER TO PANEL 3 The panel represents a portion of the lining of the small intestine. The drawing shows the fingerlike projections arranged in circular folds. Judging from the panel, the fingerlike projections and folds in the lining of the small intestine: ☐ increase the surface area of the lining of the small intestine ☐ decrease the surface area of the lining of the small intestine ☐ have no effect on the surface area of the lining of the small intestine	increase the surface area . . .

47.	
The fingerlike projections on the lining of the small intestine are called villi.*	
The villi increase the surface area of the lining of the small intestine by at least fifty fold.	
You would guess that the villi, lining the small intestines:	
☐ allow a greater absorption of digested liquid food into the blood stream	allow a greater absorption . . .
☐ do not allow a greater absorption of digested liquid food into the blood stream	
☐ have no effect on a greater absorption of digested liquid food into the blood stream	
48.	
Digested food material is absorbed into the blood stream through:	
☐ the lining of the large intestine	
☐ the villi of the small intestine	the villi of the small intestine
☐ the fingerlike projections in the lining of the stomach	
Villi:	
☐ are only occasionally found in the small intestine	
☐ are found in large numbers in the small intestine	are found in large numbers . . .
☐ line the walls of the small intestine	line the walls of the small . . .
☐ are never found in the small intestine	
*You can remember that villi means fingers by the shape of the villis.	

49.	
The small intestine (CHECK all that are correct):	
☐ is where digestion begins	
☐ is where digestion is completed	is where digestion is completed
☐ contains glands that secrete enzymes	contains glands that . . .
☐ does not produce any enzymes	
☐ absorbs the useful products of digestion	absorbs the useful . . .
☐ passes food on to structures that absorb digested food particles	
☐ is before the large intestine	is before the large intestine
☐ is after the large intestine	
50.	
The small intestine contains a solution of digested food particles, undigested food particles, and the waste products of digestion.	
The villi lining the small intestine absorb:	
☐ digested food particles	digested food particles
☐ waste products of digestion	
☐ undigested proteins, carbohydrates, and lipids	
You would expect, therefore, that the materials entering the large intestine would consist of:	
☐ digested food particles	
☐ waste products of digestion	waste products of digestion
☐ undigested proteins, carbohydrates, and lipids	undigested proteins, . . .
which are:	
☐ in solution	in solution
☐ in a somewhat solid form	

51.	
The villi of the small intestine absorb the digested food particles, but they do not absorb the waste products and undigested food substances. These substances enter the large intestine suspended in liquid.	
However, since waste is normally eliminated from the anus, at the end of the large intestine, in a solid form, you would expect that:	
☐ fluid is absorbed by the large intestine	fluid is absorbed by the . . .
☐ the activity of the large intestine does not involve the absorption of excess fluid from its contents	
52.	
Fluid is absorbed from the large intestine;*the somewhat solid substance left is eliminated from the body at the anus.	
Waste products leaving the body from the large intestine contain:	
☐ more water than solid waste products in the small intestine	
☐ less water than solid waste products in the small intestine	less water than solid . . .
As described, the functions of the large intestine are:	
☐ ingestion	
☐ excretion	excretion
☐ secretion	
☐ absorption	absorption
*This fluid passes through the kidney for purification. Purified fluid enters the blood stream; impure liquids are excreted as urine.	

53.		
MATCH the columns below:		
A. small intestine	1. _____ is about 5 feet long	1. B
B. large intestine	2. _____ is about 20 feet long	2. A
	3. _____ structure from which wastes are eliminated from the body	3. B
	4. _____ where digested food absorbed	4. A
	5. _____ where digestion is completed	5. A
	6. _____ where a large amount of water is absorbed	6. B

54.	
DO NOT REFER TO THE PANELS	
NUMBER the structures below from 1 to 7 in the order that food material passes through them:	
_____ esophagus	3
_____ large intestine	6
_____ mouth	1
_____ anus	7
_____ small intestine	5
_____ stomach	4
_____ pharynx	2

55. PREVIEW FRAME You already know the part that the liver plays in the digestion of food. It produces a secretion, bile, that emulsifies lipids. In the following frames, you will learn about another important activity that the liver performs. NO RESPONSE REQUIRED	GO ON TO THE NEXT FRAME
56. The liquid materials absorbed by the villi in the small intestine are passed on through the liver. Food entering the liver: ☐ has been digested ☐ has not been digested In this respect, the liver: ☐ is similar to organs such as the stomach and the small intestine in that it breaks down food ☐ is not similar to organs such as the stomach and the small intestine in that it does not break down food	has been digested is not similar . . .

57.	
REVIEW FRAME	
Metabolism is:	
☐ only the building up of substances	
☐ only the breaking down of substances	
☐ both the building up and the breaking down of substances	both the building up . . .
Catabolism is:	
☐ only the building up of substances	
☐ only the breaking down of substances	only the breaking down . . .
☐ both the building up and the breaking down of substances	
Anabolism is:	
☐ only the building up of substances	only the building up . . .
☐ only the breaking down of substances	
☐ both the building up and the breaking down of substances	
These words come from Greek: -bolism - change meta- - with ana- - upward cata- - downward	

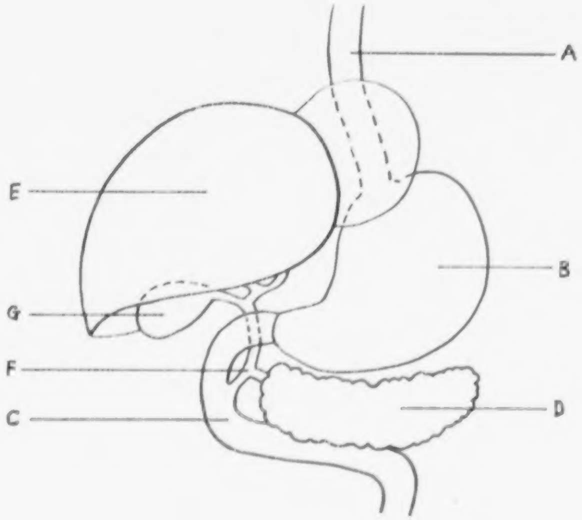
58.	
Digestion breaks carbohydrates down into glucose. However, the body does not store this food in the form of glucose. In the liver, glucose is built up into a substance, called glycogen, for storage.	
Ingested carbohydrates, therefore: ☐ become glucose before becoming glycogen ☐ become glycogen before becoming glucose	become glucose before . . .
The change from carbohydrates to glucose is a(n): ☐ anabolic process ☐ catabolic process	catabolic process
The change from glucose to glycogen is a(n): ☐ anabolic process ☐ catabolic process	anabolic process
Is one of the functions of the liver carbohydrate metabolism? ☐ yes ☐ no	yes
59.	
Digested carbohydrates are absorbed by the small intestine as: ☐ glucose ☐ glycogen	glucose
Digested carbohydrates are stored in the liver as: ☐ glucose ☐ glycogen	glycogen

60.	
When the body needs a source of energy, glycogen stored in the liver is transformed back into glucose. The glucose is carried in the blood to the cells where it is oxidized to release energy.	
Glucose is changed to glycogen in the: ☐ liver ☐ villi ☐ blood stream ☐ cell where it is oxidized to release energy	liver
Glycogen is changed to glucose in the: ☐ liver ☐ villi ☐ blood stream ☐ cell where it is oxidized to release energy	liver
NUMBER the steps as they occur in the human body:	
_____ glucose is converted to glycogen	2
_____ carbohydrates are broken down to glucose	1
_____ glycogen is converted to glucose to be utilized by cells in an energy-producing reaction	3
61.	
The form of carbohydrate that is oxidized by the cells is: ☐ glucose ☐ glycogen	glucose

62.	
The liver also builds up and breaks down lipids and proteins. However, since each of these processes involve many products, we will not discuss them further here.	
The metabolic functions of the liver consist of:	
☐ carbohydrate metabolism	carbohydrate metabolism
☐ protein metabolism	protein metabolism
☐ fat metabolism	
63.	
The liver:	
☐ digests carbohydrates	
☐ secretes an enzyme that digests carbohydrates, lipids, and proteins	
☐ stores an enzyme	
☐ stores glycogen	stores glycogen
☐ converts glycogen to glucose	converts glycogen to glucose
☐ metabolizes only carbohydrates	
☐ stores bile	
☐ metabolizes carbohydrates, lipids, and proteins	metabolizes carbohydrates, . . .

64.

IDENTIFY the structures below by WRITING one letter in each blank:



1. _____ stomach	1. B
2. _____ esophagus	2. A
3. _____ gall bladder	3. G
4. _____ liver	4. E
5. _____ small intestine	5. C
6. _____ common bile duct	6. F
7. _____ pancreas	7. D

Time completed ______________

YOU HAVE NOW FINISHED THE FIRST PART OF THIS LESSON. WRITE DOWN THE TIME. THEN, AFTER YOU HAVE REVIEWED THE MAIN IDEAS IN THE FOLLOWING SUMMARY, TAKE THE MASTERY TEST AT THE END OF THE BOOKLET.

WORD	DEFINITION
DIGESTION	is the physical and chemical breakdown of food.
GLANDS	are organs that produce secretions.
AN ENZYME	is a catalyst that is produced by the body.
DIGESTION begins in the mouth where the teeth break the food down physically and saliva initiates a chemical breakdown.	Saliva is produced by the salivary glands. Saliva is mostly water, but it also contains ptyalin which is an enzyme that digests starch.
From the mouth the food passes to the pharynx, which leads to the esophagus, and then to the stomach.	The pharynx is a common passageway for food and air. The esophagus is a tube about 10 inches long that carries the food to the stomach.
Food is changed physically and chemically (by the action of gastric juice) in the stomach and, after 3 to 5 hours, finally leaves the stomach in a liquid form.	Gastric juice is secreted by the gastric glands in the lining of the stomach. Gastric juice contains an enzyme (pepsin) and hydrochloric acid which acts on proteins.
The liver produces bile. Bile is stored in a small sac near the liver; this sac is called the gall bladder.	Bile is not an enzyme, but it aids the digestion of lipids by emulsifying them.
The liver also metabolizes carbohydrates, lipids, and proteins.	The carbohydrate metabolism that takes place in the liver involves: the building up of glucose to glycogen (a form of carbohydrate that is stored by the body) and the breaking down of glycogen to glucose when it is needed by the body's cells for the oxidation process.
The pancreas produces pancreatic juice. Bile and pancreatic juice are carried by the common bile duct to the small intestine.	Pancreatic juice contains enzymes that help digest carbohydrates, lipids, and proteins.

WORD	DEFINITION
The small intestine is a tube about 20 feet long. The lining of the small intestine contains glands that secrete intestinal juice. The chemical digestion of food is completed in the small intestine. The digested food is then absorbed into the blood stream by the villi.	Intestinal juice contains enzymes that help digest carbohydrate, lipids, and proteins. The villi are fingerlike projects which increase the absorptive area of the lining of the small intestine.
The large intestine is a tube about 5 feet long. Undigested food material are in liquid form when they first enter the large intestine.	Water is reabsorbed into the system from the large intestine so that waste products are eliminated from the anus in a somewhat solid form.

MASTERY TEST

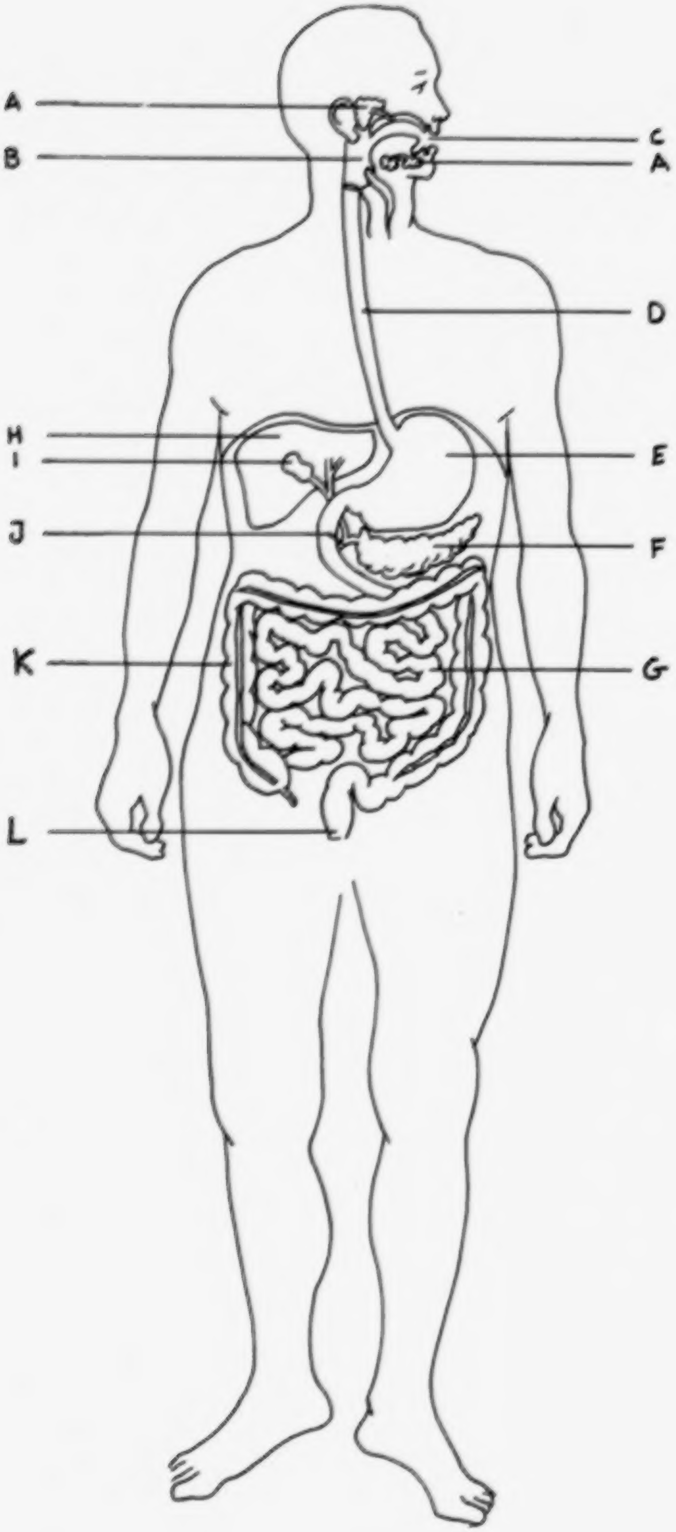
Time started ______________

Each letter refers to a structure that is shown on **page 42 (Skip one(1) page to find page 42) MATCH each letter with the items listed below:**

1. _____ a common passageway for food and air
2. _____ carries bile and pancreatic juice to the small intestine
3. _____ carries food to the stomach
4. _____ changes glucose to glycogen
5. _____ contains the gastric glands
6. _____ produces pancreatic juice
7. _____ produces saliva
8. _____ stores bile
9. _____ where digested food is absorbed by the villi
10. _____ where large quantities of water are absorbed
11. _____ where the action of ptyalin begins
12. _____ where undigested food is eliminated

Time completed ______________

WHEN YOU HAVE FINISHED THIS TEST, WRITE DOWN THE TIME. THEN TAKE THE LESSON TO YOUR INSTRUCTOR OR HIS ASSISTANT FOR CHECKING. WAIT UNTIL THE LESSON IS APPROVED BEFORE GOING ON TO THE NEXT LESSON.


A
C
B
A
D
H
I
E
J
F
K
G
L

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ADVANCED
GENERAL EDUCATION PROGRAM

A HIGH SCHOOL SELF-STUDY PROGRAM

FUNCTIONS OF THE BLOOD

LEVEL: III
UNIT: 3
LESSON: 3

U.S. DEPARTMENT OF LABOR
MANPOWER ADMINISTRATION, JOB CORPS
NOVEMBER 1969

81

U.S. DEPARTMENT OF LABOR
MANPOWER ADMINISTRATION, JOB CORPS
NOVEMBER 1969

1. PREVIEW FRAME In the previous lesson you learned how the body digests food to provide nourishment for the cells. You learned that the digested food enters the blood stream through the walls of the small intestine. Later you will learn how the blood moves around the body, carrying food to the cells and performing many other functions. First, however, in this lesson, you will learn about the composition of the blood. NO RESPONSE REQUIRED	GO ON TO THE NEXT FRAME
2. There are two main parts of the blood: a fluid portion (about 55% of the blood by volume) in which elements (cells or pieces of cells) are suspended. These cells or pieces of cells are called the formed elements. About 45% of the blood by volume consists of: ☐ formed elements ☐ cells suspended in a fluid ☐ a fluid	formed elements cells suspended in a fluid

3.	
The fluid portion of the blood is called plasma.	
There are three types of formed elements suspended in the plasma: one formed element is a red colored cell, a second formed element is an almost transparent cell, the third formed element consists of colorless pieces of cells.	
About 45% of the blood consists of:	
☐ colorless cells and pieces of cells	colorless cells and pieces of cells
☐ cells with a red pigment*	cells with a red pigment
☐ plasma	
About 55% of the blood consists of:	
☐ colorless cells and pieces of cells	
☐ cells with a red pigment	
☐ plasma	plasma
*Pigment, meaning coloring material, comes from the Latin word for paint.	

4. The cells that contain a red pigment are called red blood cells or simply RBC's. The transparent cells are called white blood cells or WBC's. The colorless pieces of cells are called platelets. CHECK the formed element(s) of the blood listed below: ☐ RBC's ☐ WBC's ☐ a colorless pigment ☐ plasma ☐ platelets CHECK the name of the fluid portion of the blood: ☐ plasma ☐ platelets ☐ RBC's ☐ WBC's ☐ a colorless pigment Which of the formed elements listed below contains a pigment? ☐ RBC's ☐ WBC's ☐ platelets	RBC's WBC's platelets plasma RBC's
5. In every cubic inch of blood there are about: 100,000,000 (100 million) WBC 4,000,000,000 (4 billion) platelets 75,000,000,000 (75 billion) RBC It is obvious that the most numerous formed elements in the blood are the: ☐ platelets ☐ RBC's ☐ WBC's	RBC's

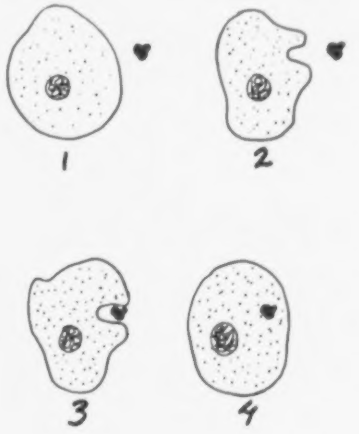
6.	
The formed elements of the blood are: ☐ plasma ☐ red blood cells ☐ white blood cells ☐ platelets	red blood cells white blood cells platelets
The liquid portion of the blood is: ☐ plasma ☐ red blood cells ☐ white blood cells ☐ platelets	plasma
The most numerous formed element in the blood: ☐ contains a red pigment ☐ is colorless	contains a red pigment
7.	
The red pigment contained in one of the blood's formed elements is called hemoglobin.* Hemoglobin is a protein which contains iron that readily unites with oxygen which RBC carries to the cells.	
Hemoglobin is found in: ☐ RBC's ☐ WBC's ☐ platelets	RBC's
You would suppose that the primary function of the RBC's is: ☐ to carry oxygen to the cells ☐ to give the blood its color ☐ supply the body with protein	to carry oxygen to the cells
*Hemoglobin (he-mo-globe-in), from Greek heme-(red)-globin (particle), is a protein.	

8. Hemoglobin also plays an important role in taking carbon dioxide from the cells. Which formed element listed below helps remove carbon dioxide from the cells? ☐ RBC's ☐ WBC's ☐ platelets	RBC's
9. All of the WBC's can change the shape of their cytoplasm* and move around easily. The percentage of the formed elements in the blood: ☐ is constant ☐ is subject to change *Cytoplasm (sight-o-plasim) is Greek for the hollow (cyto-) thing formed (plasm) surrounding the center of a cell.	is constant

10.

The formed element of the blood that can change its shape and position fairly easily often does so in order to catch pieces of undesirable material.

The drawing below shows how that formed element of the blood would extend its cytoplasm so that it can engulf an object.



The formed element shown above is a:

- ☐ WBC
- ☐ RBC
- ☐ platelet

WBC

11.	
The percentage of formed elements in the blood stream is affected by the number of bacteria* that cause infection and by the amount of injured or dead cells present in the tissues.	
CHECK the formed element below whose primary function you think it is to engulf these undesirable materials.	
☐ the WBC's	the WBC's
☐ the RBC's	
☐ the platelets	
*Bacteria is the medical term for what most of us call germs.	
12.	
Since it is the function of most WBC's to engulf this undesirable material, the number of WBC's is affected by the presence of bacteria and dead or injured tissue.	
The process whereby undesirable material is engulfed by the WBC's is called phagocytosis. The WBC's performing the process are called phagocytes.* Not all WBC's are phagocytes.	
Phagocytes are found:	
☐ only in the plasma	
☐ in the blood stream	in the blood stream
☐ only around dead tissues and bacteria	
☐ between the spaces of the cells	between the spaces of the cells
*Phagocytes (fag-o-sights) from Greek (phago-) eating (-cyte) cell.	

13.	
Phagocytosis is performed by: ☐ most WBC's ☐ all phagocytes ☐ most RBC's ☐ all platelets	most WBC's all phagocytes
Phagocytosis is described as resembling: ☐ ingestion ☐ assimilation ☐ digestion	ingestion
14.	
The engulfing of undesirable material that most WBC's perform is called: ☐ phagocytosis ☐ phagocytes ☐ platelets	phagocytosis
The WBC's that engulf undesirable material are called: ☐ phagocytosis ☐ phagocytes ☐ platelets	phagocytes
15.	
Hemoglobin is carried by: ☐ red pigmented cells ☐ colorless cells ☐ colorless pieces of cells	red pigmented cells
Phagocytosis is performed by: ☐ red pigmented cells ☐ colorless cells ☐ colorless pieces of cells	colorless cells

16. The colorless pieces of cells in the plasma contain a substance that starts blood clotting if the body is cut. You have had cuts or scratches that formed a scab to protect the cut and keep germs out. Scabs are formed by blood clotting. A formed element that helps the blood clot is a: ☐ RBC ☐ WBC ☐ platelet	platelet
17. MATCH the columns below by placing one or more numbers next to each letter:	
1. RBC's A. _____ contain a substance that initiates a series of reactions that result in the blood clotting 2. WBC's	3
3. platelets B. _____ usually perform phagocytosis	2
C. _____ contain hemoglobin which helps transport oxygen to the cells and carbon dioxide away from the cells	1
D. _____ are colorless	2, 3
E. _____ contain a red pigment	1
F. _____ most of these are phagocytes	2
18. The fluid portion of the blood is called _______________.	plasma

19. PREVIEW FRAME You now know what the formed elements of the blood are and the function they perform. In the next few frames we will discuss the plasma more fully. NO RESPONSE REQUIRED	GO ON TO THE NEXT FRAME
20. You have already learned that most of the WBC's can engulf bacteria. The plasma contains a chemical which also helps defend the body against infection. This substance does not engulf material but it does react chemically with it. The plasma also contains a chemical which plays a role in the clotting of blood. Neither of the substances described is a cell; both of them are proteins made by the body. The first protein described is similar in function to: ☐ the phagocytes ☐ the platelets The second protein described is similar in function to: ☐ the phagocytes ☐ the platelets	the phagocytes the platelets

21. The protein that defends the body against bacterial invasion is called an antibody. The protein that plays a role in blood clotting is called fibrinogen.* Antibodies and fibrinogen are substances found in: ☐ the platelets ☐ the phagocytes ☐ the plasma *Fibrinogen (fib-rin-o-gen) comes from the same root-word as fiber and means to make a net.	the plasma
22. A protein in the plasma that protects the body from infection is called: ☐ an antibody ☐ fibrinogen In function, this substance is similar to the: ☐ phagocytes ☐ platelets A protein in the plasma that plays a role in blood clotting is called: ☐ an antibody ☐ fibrinogen In function, this substance is similar to the: ☐ phagocytes ☐ platelets	an antibody phagocytes fibrinogen platelets

23.	
An antibody:	
☐ is a cell	
☐ is not a cell	is not a cell
A phagocytes:	
☐ is a cell	is a cell
☐ is not a cell	
Fibrinogen:	
☐ is a piece of cell	
☐ is not a piece of cell	is not a piece of cell
A platelet:	
☐ is a piece of cell	is a piece of cell
☐ is not a piece of cell	

24.	
In a previous lesson you learned that the blood carries food and oxygen to the body's cells, and carbon dioxide away from the cells. The food is carried in the clear liquid part of the blood. The gases, oxygen and carbon dioxide, are carried by the blood cells which contain hemoglobin.	
Thus, in the blood, food substances are carried along by the:	
☐ antibodies	
☐ phagocytes	
☐ plasma	plasma
☐ red blood cells	
Oxygen and carbon dioxide are carried by the:	
☐ antibodies	
☐ bacteria	
☐ phagocytes	
☐ plasma	
☐ red blood cells	red blood cells
25.	
The blood also carries away the end products of the energy-producing reaction that takes place in the cell.	
The plasma carries to the cell:	
☐ digested food particles	digested food particles
☐ the waste products of digestion	
☐ RBC's that contain oxygen	RBC's that contain oxygen
☐ RBC's that contain carbon dioxide	
The plasma carries away from the cell:	
☐ digested food particles	
☐ the waste products of digestion	the waste products of digestion
☐ RBC's that contain oxygen	
☐ RBC's that contain carbon dioxide	RBC's that contain carbon dioxide

26.	
Food for the cells is carried: ☐ by the WBC's ☐ by the RBC's ☐ in the plasma	in the plasma
Oxygen and carbon dioxide are carried: ☐ by the WBC's ☐ by the RBC's ☐ in the plasma	by the RBC's
The waste products of digestion are carried from the cell: ☐ by the WBC's ☐ by the RBC's ☐ in the plasma	by the RBC's
27.	
Another group of substances carried in the plasma are special chemicals, some of which regulate the growth of the body, others of which control the activities of various organs.	
The plasma: ☐ carries secretions ☐ does not carry secretions	carries secretions

28. Enzymes are secretions produced by the body which control the digestive function. Some other secretions produced by the body which control growth or other activities are called hormones. Hormones and enzymes are carried: ☐ in the plasma ☐ by the RBC's ☐ by the WBC's	in the plasma
29. Which of the following statements must be true of some type of hormone? ☐ Protects the body from infection by destroying bacteria. ☐ Controls the size of the body. ☐ Carries carbon dioxide and oxygen. ☐ Regulates certain organ functions. Hormones are carried in the blood in the same way as: ☐ antibodies ☐ carbon dioxide ☐ oxygen	Controls the size of the body. Regulates certain organ functions. antibodies

30.	
Two components of the blood which protect the body from danger are:	
☐ red blood cells ☐ antibodies ☐ phagocytes ☐ plasma	antibodies phagocytes
Two components of the blood which aid the blood in clotting are:	
☐ platelets ☐ fibrinogen ☐ antibodies ☐ hormones	platelets fibrinogen
31.	
MATCH the terms to the functions below by writing one or more letters in each blank:	
A. hormones B. antibody C. phagocyte D. fibrinogen E. platelet F. enzymes	
_____ helps clot the blood	D, E
_____ protects the body against bacterial invasion	B, C
_____ secretions which control activities in certain organs	A, F

32.	
Gaseous materials going to and from the cell are carried by the:	
☐ RBC's	RBC's
☐ plasma	
Digested food particles and the end products of digestion are carried by the:	
☐ RBC's	
☐ plasma	plasma
33.	
WRITE a P in front of the items below that are carried in the plasma. WRITE an F in front of the items below that are carried in a formed element.	
_____ RBC, WBC, platelets	P
_____ hemoglobin	F
_____ oxygen and carbon dioxide	F
_____ hormones and enzymes	P
_____ fibrinogen and antibodies	P
_____ digested food particles and the waste products of digestion	P
	Time completed _______________

YOU HAVE NOW FINISHED THE FIRST PART OF THIS LESSON. WRITE DOWN THE TIME. THEN, AFTER YOU HAVE REVIEWED THE MAIN IDEAS IN THE FOLLOWING SUMMARY, TAKE THE MASTERY TEST AT THE END OF THE BOOKLET.

The blood is composed of a fluid called plasma and formed elements which are actually cells or pieces of cells.	About 55% of the blood is plasma; about 45% consists of formed elements. The main formed elements of the blood are: red blood corpuscles (RBC's), white blood corpuscles (WBC's), and platelets (transparent pieces of cells).
THE FORMED ELEMENTS:	
The RBC's, the most numerous of the formed elements give the blood its color because they contain a red pigment called hemoglobin.	Hemoglobin helps transport oxygen to the cells and carbon dioxide away from the cells.
WBC's are transparent cells whose number is increased by the presence of bacteria and injured or dead cells because the WBC's can engulf this undesirable material (a process known as phagocytosis).	Phagocytes those WBC's that can perform the engulfing process known as phagocytosis. Phagocytes are not only found in the plasma, but also between the spaces of the body's cells.
Platelets are colorless pieces of cells that play a role in the blood clotting process.	
THE PLASMA CONTAINS:	
ANTIBODIES	An antibody is a protein synthesized by the body that helps defend it against bacterial invasion.
FIBRINOGEN	Fibrinogen is a protein that also plays a role in the blood clotting process.
HORMONES	Hormones are secretions of the body which control growth and other activities.
ENZYMES	Enzymes are secretions produced by the body which control the digestive function.
DIGESTED FOOD PARTICLES	used by the cells in the energy-producing reaction.
WASTE MATERIALS	produced by the cells as a result of the oxidation process.

MASTERY TEST

Time started ________________

1. Hemoglobin is found in:

   a. ☐ RBC's

   b. ☐ WBC's

   c. ☐ platelets

   d. ☐ all formed elements

2. The primary function of the RBC's is to:

   a. ☐ carry oxygen and carbon dioxide to and from the cell

   b. ☐ carry food and the waste materials of digestion to and from the cell

   c. ☐ engulf undesirable material

   d. ☐ carry chemicals that help the blood to clot

3. Bacteria are destroyed in the human body by (CHECK one or more):

   a. ☐ phagocytes

   b. ☐ platelets

   c. ☐ fibrinogen

   d. ☐ hormones

   e. ☐ antibodies

4. A chemical carried in the plasma that helps the blood clot is:

   a. ☐ an antibody

   b. ☐ a hormone

   c. ☐ an enzyme

   d. ☐ fibrinogen

5. Digested food particles and the waste materials of digestion are carried from the cell by:

   a. ☐ the RBC's

   b. ☐ the WBC's

   c. ☐ the platelets

   d. ☐ the plasma

Time completed ________________

WHEN YOU HAVE FINISHED THIS TEST, WRITE DOWN THE TIME. THEN TAKE THE LESSON TO YOUR INSTRUCTOR OR HIS ASSISTANT FOR CHECKING. WAIT UNTIL THE LESSON IS APPROVED BEFORE GOING ON TO THE NEXT LESSON.

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ADVANCED
GENERAL EDUCATION PROGRAM

A HIGH SCHOOL SELF-STUDY PROGRAM

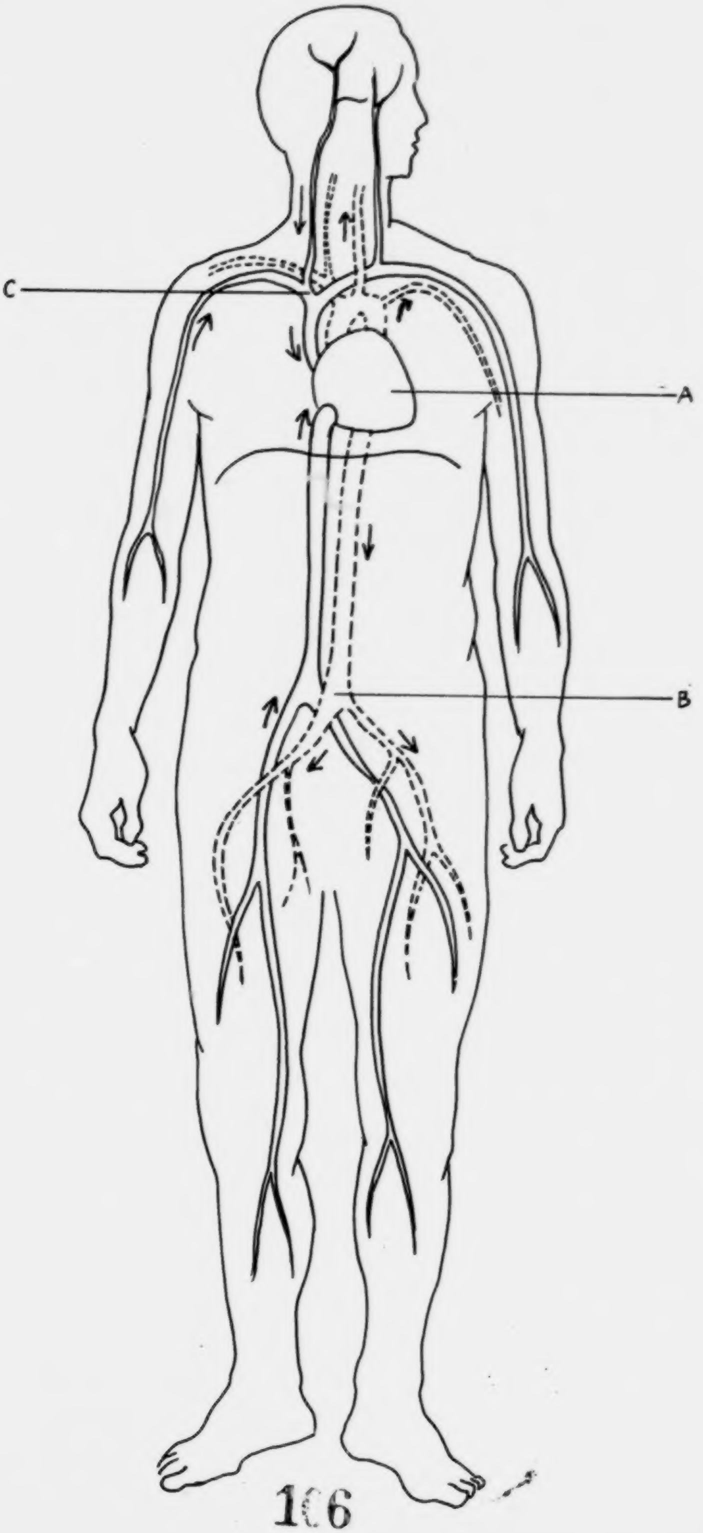
HUMAN CIRCULATION AND RESPIRATION
LEVEL: III
UNIT: 3
LESSON: 4

U.S. DEPARTMENT OF LABOR
MANPOWER ADMINISTRATION, JOB CORPS
NOVEMBER 1969

104

U.S. DEPARTMENT OF LABOR
MANPOWER ADMINISTRATION, JOB CORPS
NOVEMBER 1969

PANEL 1



1.

PREVIEW FRAME

You have learned some of the most important constituents of the blood. In the remainder of this lesson you will learn how the blood is carried to all parts of the body. The next section will also give you a more detailed description of the system that circulates the blood, called the circulatory system.

NO RESPONSE REQUIRED

GO ON TO THE NEXT FRAME

2.

REFER TO PANEL 1 - The panel is a representative drawing of the circulatory system.

The system which carries the blood to all parts of the body consists of an organ which acts like a pump to keep the blood circulating, and many miles of tubes or vessels through which the blood flows.

The organ which pumps the blood is called the heart. It is labelled A in the panel. The vessels which carry blood away from the heart and distribute it to the body parts are called arteries. The vessels which collect the blood and return it to the heart are called veins.

LOOK AT the arrows in the panel.

The arteries are indicated in the panel by:

- ☐ dotted lines
- ☐ solid lines

The veins are indicated by:

- ☐ dotted lines
- ☐ solid lines

The heart:

- ☐ carries blood to the body's parts
- ☐ carries blood from the body's parts
- ☐ pumps the blood

dotted lines

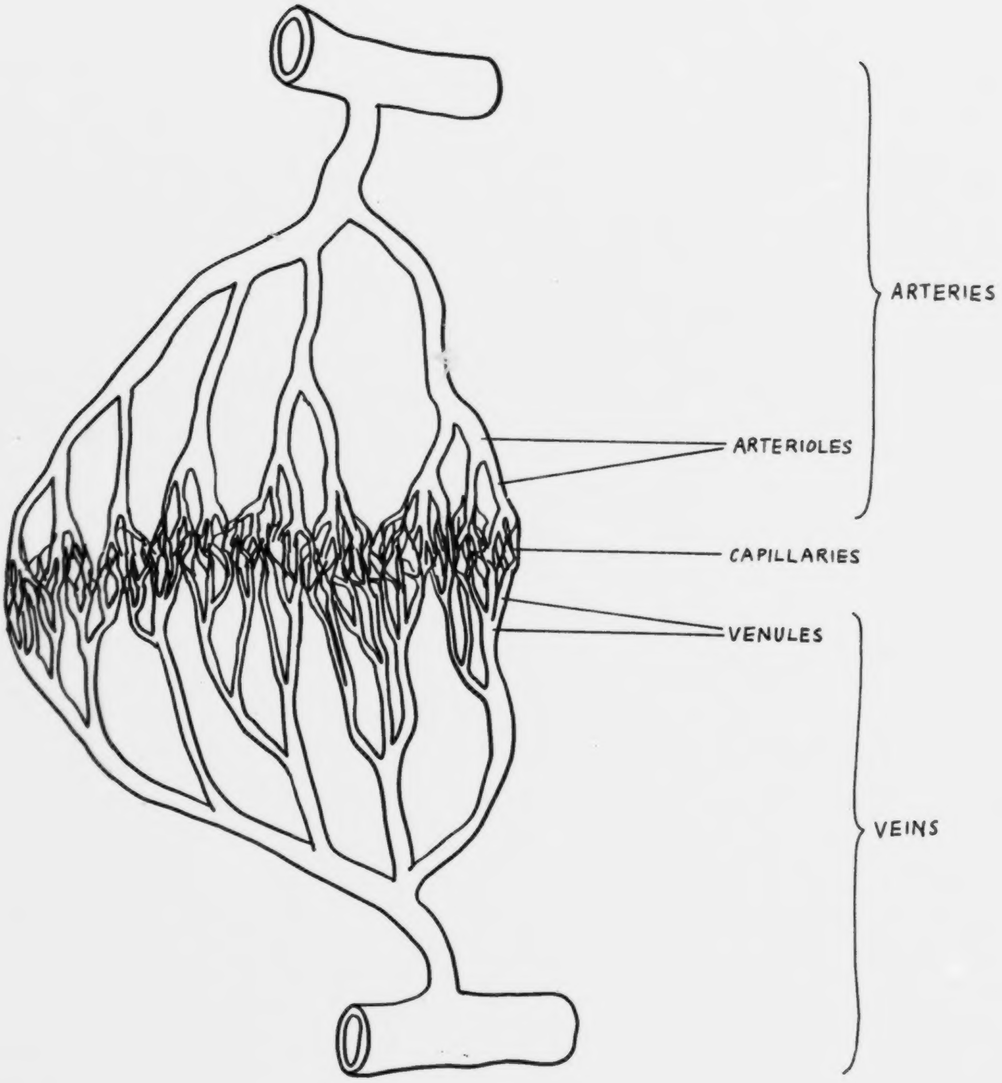
solid lines

pumps the blood

3. REFER TO PANEL 1 The veins carry blood: ☐ to the body's parts from the heart ☐ to the heart from the body's parts	to the heart from the body's parts
The arteries carry blood: ☐ to the body's parts from the heart ☐ to the heart from the body's parts	to the body's part from the heart
4. REFER TO PANEL 1 LOOK AT Point B in the panel. At this point, the blood: ☐ from smaller arteries flows into one larger artery ☐ from one larger artery flows into two smaller arteries ☐ from smaller veins flows into one larger vein ☐ from one large vein flows into two smaller veins	. . . into two smaller arteries
From Point B the blood flows: ☐ into the legs ☐ out of the legs	into the legs
At Point C in the panel, the blood flows from: ☐ smaller arteries into one larger artery ☐ one large artery into smaller arteries ☐ smaller veins into one larger vein ☐ one large vein into smaller veins	smaller veins into one larger vein
At Point C the blood is: ☐ moving toward the heart ☐ moving away from the heart	moving toward the heart

5.	
DO NOT REFER TO THE PANEL	
The organ which pumps the blood is called a(n):	
☐ artery ☐ heart ☐ vein	heart
Veins carry blood:	
☐ away from the heart ☐ toward the heart	toward the heart
Arteries carry blood:	
☐ away from the heart ☐ toward the heart	away from the heart
Blood is distributed to the body's parts:	
☐ by a single vessel that goes everywhere in the body	
☐ by large vessels that branch out into many smaller vessels	by large vessels that branch . . .
The veins collect blood:	
☐ from smaller vessels that lead into larger vessels	from smaller vessels that . . .
☐ from larger vessels that lead into smaller vessels	

PANEL 2


ARTERIES
ARTERIOLES
CAPILLARIES
VENULES
VEINS

6.	
DO NOT REFER TO THE PANEL	
MATCH the columns by writing one or more letters in each blank:	
A. artery 1. ______ acts like a pump	1. B
B. heart 2. ______ acts like a tube	2. A, C
C. vein 3. ______ has a branching structure	3. A, C
7.	
REFER TO PANELS 1 and 2	
Panel 1 does not show how blood from the arteries reaches the veins in order to return to the heart.	
Panel 2 indicates how this is done. The Panel shows a large branching off into smaller arteries. These smaller arteries then branch off into even smaller arteries called:	
☐ arterioles ☐ capillaries ☐ venules	arterioles
Larger veins collect blood from smaller veins called:	
☐ arterioles ☐ capillaries ☐ venules	venules
Blood passes from arterioles into venules through minute vessels in the body's tissue. These vessels are called:	
☐ arteries ☐ capillaries ☐ veins	capillaries

8.	
DO NOT REFER TO THE PANEL	
Arterioles are small: ☐ arteries ☐ capillaries ☐ veins	arteries
Venules are small: ☐ arteries ☐ capillaries ☐ veins	veins
The minute vessels between the arteries and the veins are: ☐ arterioles ☐ capillaries ☐ venules	capillaries

9.	
DO NOT REFER TO PANEL 2	
Even the walls of the small arteries and veins, the arterioles and venules, are thicker than the walls of the capillaries. The **capillary** walls are usually composed of a single layer of cells. You would therefore expect that food and oxygen reach the body's cells by passing through the walls of the: ☐ arteries ☐ arterioles ☐ capillaries ☐ venules ☐ veins	capillaries
As you know the blood brings food and oxygen to the body's cells and carries off carbon dioxide and other wastes. Evidently, waste materials from the cells enter the blood via the walls of the: ☐ arterioles ☐ capillaries ☐ venules	capillaries
On its way back to the heart, the blood now carrying the waste materials flows from the capillaries to the: ☐ arteries ☐ arterioles ☐ venules	venules
and eventually into the larger: ☐ arteries ☐ capillaries ☐ veins	veins

10.	
DO NOT REFER TO THE PANEL	
Recall that both arteries and veins have a branching structure, like a tree.	
CHECK the true statement(s) below:	
☐ A larger artery flows into many arterioles	A large artery flows into . . .
☐ A larger vein flows into many venules	
☐ Many arterioles flow into a larger artery	
☐ Many venules flow into a larger vein	Many venules flow into a . . .
11.	
DO NOT REFER TO THE PANEL	
On its trip from the heart and back to the heart, the blood passes through the following vessels.	
NUMBER the vessels listed below from 1 to 5 in the order in which blood passes through them:	
_____ arteries	1
_____ arterioles	2
_____ capillaries	3
_____ veins	5
_____ venules	4
Food and oxygen carried in the blood reach the body's cells by passing through the walls of the:	
☐ arteries	
☐ arterioles	
☐ capillaries	capillaries
☐ veins	
☐ venules	

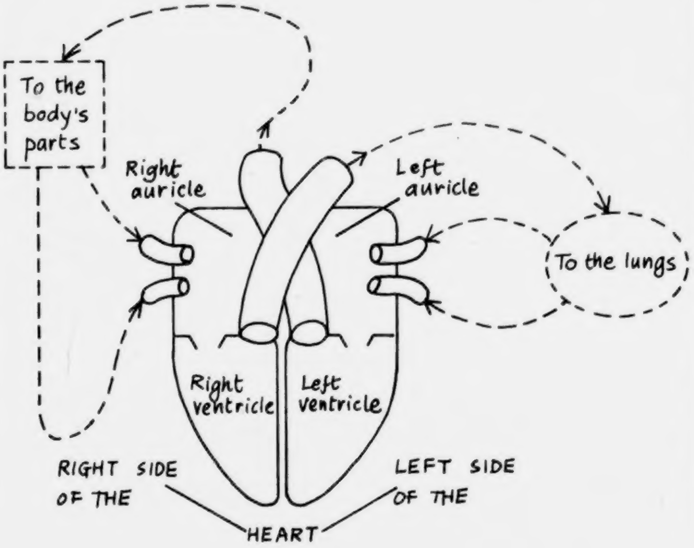
12.

PREVIEW FRAME

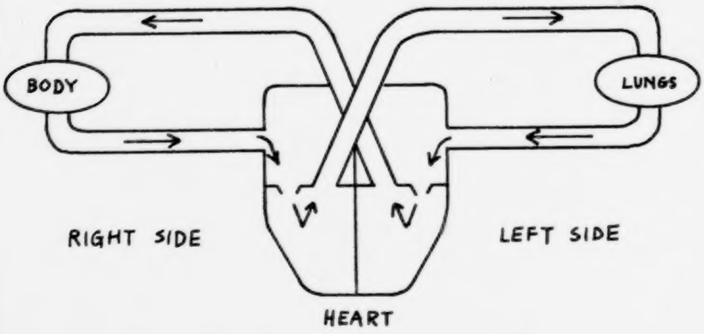
You now know what path the blood follows on its way through the body. Before the blood can repeat this path however, it must take a side trip to the lungs. How the heart does this is explained in the next section.

NO RESPONSE REQUIRED	GO ON TO THE NEXT FRAME

13.

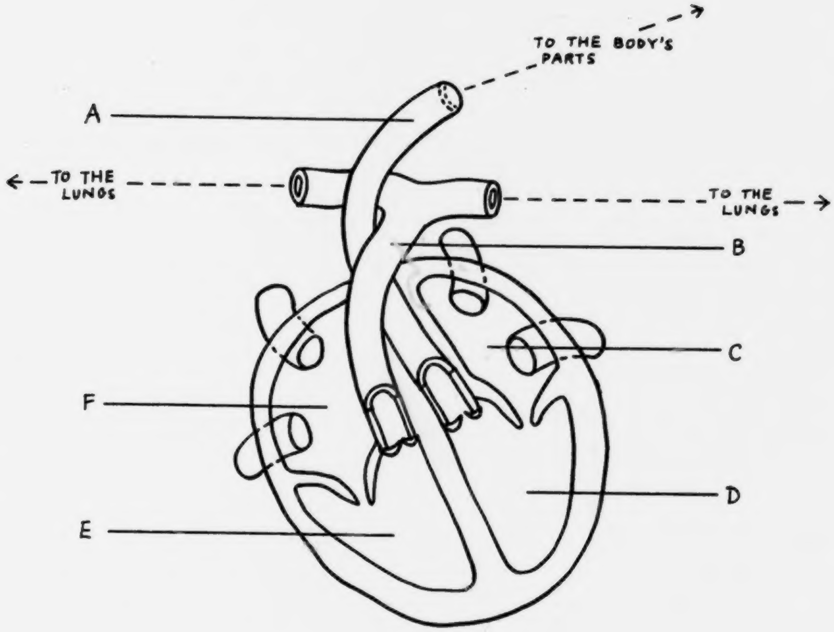

To the body's parts
Right auricle
Left auricle
To the lungs
Right ventricle
Left ventricle
RIGHT SIDE OF THE
LEFT SIDE OF THE
HEART

The above diagram bears a closer resemblance to the human heart than the diagram in Panel 1.	
Blood passes through a tube to the body's parts from the:	
☐ left auricle	
☐ left ventricle	left ventricle
☐ right auricle	
☐ right ventricle	
Blood re-enters the heart from the body's parts **into the:**	
☐ left auricle	
☐ left ventricle	
☐ right auricle	right auricle
☐ right ventricle	
The chambers of the heart passing blood to and receiving blood from the lungs are the:	
☐ left auricle	left auricle
☐ left ventricle	
☐ right auricle	
☐ right ventricle	right ventricle
Ventricles receive blood directly from:	
☐ the auricles	the auricles
☐ the body	
☐ the lungs	

14.	
	
The schematic diagram above represents the flow of blood of the heart. It is seen from the front, as though a man were facing you. Thus, the right-hand half of the diagram corresponds to the:	
☐ left-hand half of the man's heart	left-hand half of the man's heart
☐ right-hand half of the man's heart	
The heart has four "chambers," or sacs for blood. Blood entering the heart first flows into:	
☐ the two upper chambers	the two upper chambers
☐ the two lower chambers	
Before going to the lungs, blood from the body, first enters the:	
☐ left lower chanber	
☐ left upper chamber	
☐ right lower chamber	
☐ right upper chamber	the right upper chamber
Blood from the left upper chamber enters the:	
☐ left lower chamber	left lower chamber
☐ right upper chamber	
☐ right lower chamber	
Blood leaves the heart from:	
☐ the two lower chambers	the two lower chambers
☐ the two upper chambers	

15.	
The upper chambers of the heart are called auricles. The lower chambers of the heart are called ventricles.	
How many auricles does the heart have? _____	2
How many ventricles does the heart have? _____	2
Blood entering the heart goes into:	
☐ the auricles before the ventricles ☐ the ventricles before the auricles	the auricles before the ventricles
Blood leaves the heart from:	
☐ the auricles ☐ the ventricles	the ventricles
16.	
The blood vessels leading to the auricles are:	
☐ the arteries ☐ the capillaries ☐ the veins	the veins
The blood vessels leading away from the ventricles are:	
☐ the arteries ☐ the capillaries ☐ the veins	the arteries

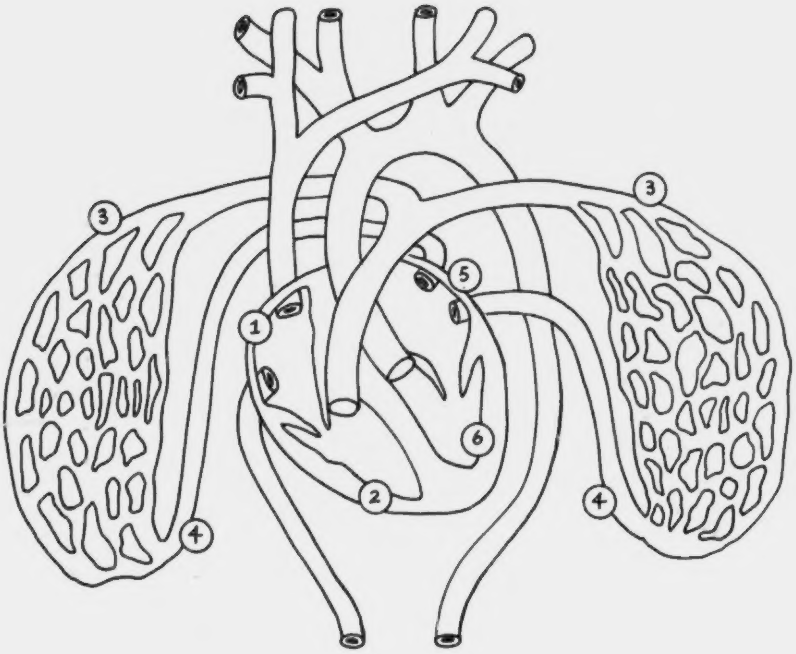
PANEL 3


TO THE BODY'S PARTS
A
TO THE LUNGS
TO THE LUNGS
B
C
F
D
E

17. REFER TO PANEL 3 The Panel shows that the blood vessel connected to the right ventricle divides into two vessels. Each of these goes to one of the two lungs. The blood vessel connected to the left ventricle:	
☐ carries blood to the body's parts	carries blood to the body's parts
☐ carries blood to the lungs	
☐ receives blood from the body's parts	
☐ receives blood from the lungs	
18. The blood vessel that carries blood to the lungs is called the pulmonary artery.* The blood vessel that carries blood to the body is called the aorta.** REFER TO PANEL 3 MATCH the structures in Panel 3 to the terms below by WRITING one letter in each blank:	
_____ aorta	A
_____ left auricle	C
_____ left ventricle	D
_____ pulmonary artery	B
_____ right auricle	F
_____ right ventricle	E
*Pulmonary is from the Greek word for lung. **Aorta is from the Greek word for carry or lift.	

19.	
REFER TO PANEL 3	
Structure C receives blood from the:	
☐ body's parts	
☐ lungs	lungs
Structure C is the:	
☐ left auricle	left auricle
☐ left ventricle	
When blood leaves Structure C, it enters the:	
☐ left ventricle	left ventricle
☐ right ventricle	
From the left ventricle, blood enters the:	
☐ aorta	aorta
☐ pulmonary artery	
the blood vessel that carries the blood to the:	
☐ body's parts	body's parts
☐ lungs	
The blood returning from the body's parts to the heart enters the:	
☐ left auricle	
☐ right auricle	right auricle
From there it goes to the:	
☐ left ventricle	
☐ right ventricle	right ventricle
From this chamber the blood enters the:	
☐ aorta	
☐ pulmonary artery	pulmonary artery

PANEL 4



20.	
REFER TO PANEL 3	
Blood flowing from the body's parts enters the heart, it then leaves the heart, passes through the lungs and returns to the heart to be pumped once more to the body's parts.	
NUMBER the structure below from 1 to 7 to indicate the order in which blood passes through them, beginning at the right auricle:	
_____ aorta	7
_____ left auricle	5
_____ left ventricle	6
_____ lungs	4
_____ pulmonary artery	3
__1__ right auricle	1
_____ right ventricle	2
21.	
REFER TO PANEL 4	
MATCH the numbered circles in the panel with the events described below by writing one number in each blank:	
_____ Blood enters the left ventricle and from there goes to the aorta, from which blood is carried to all parts of the body.	6
_____ Blood enters the right ventricle, from which it goes into the pulmonary artery.	2
_____ Blood enters the lungs.	3
_____ Blood leaves the lungs to return to the heart.	4
_____ Blood from the body's parts enters the right auricle.	1
_____ Blood from the lungs enters the left auricle.	5

22.	
REFER TO PANEL 4	
Starting with number 1, LIST the numbers of the parts in the panel in the order in which the blood passes through them:	
1	1
______	2
______	3
______	4
______	5
______	6
23.	
REFER TO PANEL 3	
MATCH the structure in the diagram on the panel to the names and descriptions below by writing one or more letters in each blank.	
______ aorta	A
______ left auricle	C
______ left ventricle	D
______ pulmonary artery	B
______ right auricle	F
______ right ventricle	E
______ through which blood leaves the left ventricle and goes to the body's parts	A
______ receives blood from the body's parts	F
______ carries blood to the lungs	B
______ receives blood from the lungs	C

24.	
DO NOT REFER TO THE PANELS	
Blood goes to the lungs from the:	
☐ left auricle	
☐ left ventricle	
☐ right auricle	
☐ right ventricle	right ventricle
When it leaves the lungs, the blood goes to the:	
☐ left auricle	left auricle
☐ left ventricle	
☐ right auricle	
☐ right ventricle	
Blood enters the aorta from the:	
☐ left auricle	
☐ left ventricle	left ventricle
☐ right auricle	
☐ right ventricle	
When blood returns to the heart from the body's parts, it first enters the:	
☐ left auricle	
☐ left ventricle	
☐ right auricle	right auricle
☐ right ventricle	

25.

DO NOT REFER TO THE PANELS

COMPLETE the table by checking the appropriate boxes:

	left auricle	right auricle	left ventricle	right ventricle	left auricle	right auricle	left ventricle	right ventricle
supplies blood to the aorta	☐	☐	☐	☐	☐	☐	☒	☐
supplies blood to the pulmonary artery	☐	☐	☐	☐	☐	☐	☐	☒
receives blood coming into the heart	☐	☐	☐	☐	☒	☒	☐	☐
receives blood from the right auricle	☐	☐	☐	☐	☐	☐	☐	☒
supplies blood to the left ventricle	☐	☐	☐	☐	☒	☐	☐	☐
receives blood from the lungs	☐	☐	☐	☐	☒	☐	☐	☐
receives blood from the body's parts	☐	☐	☐	☐	☐	☒	☐	☐

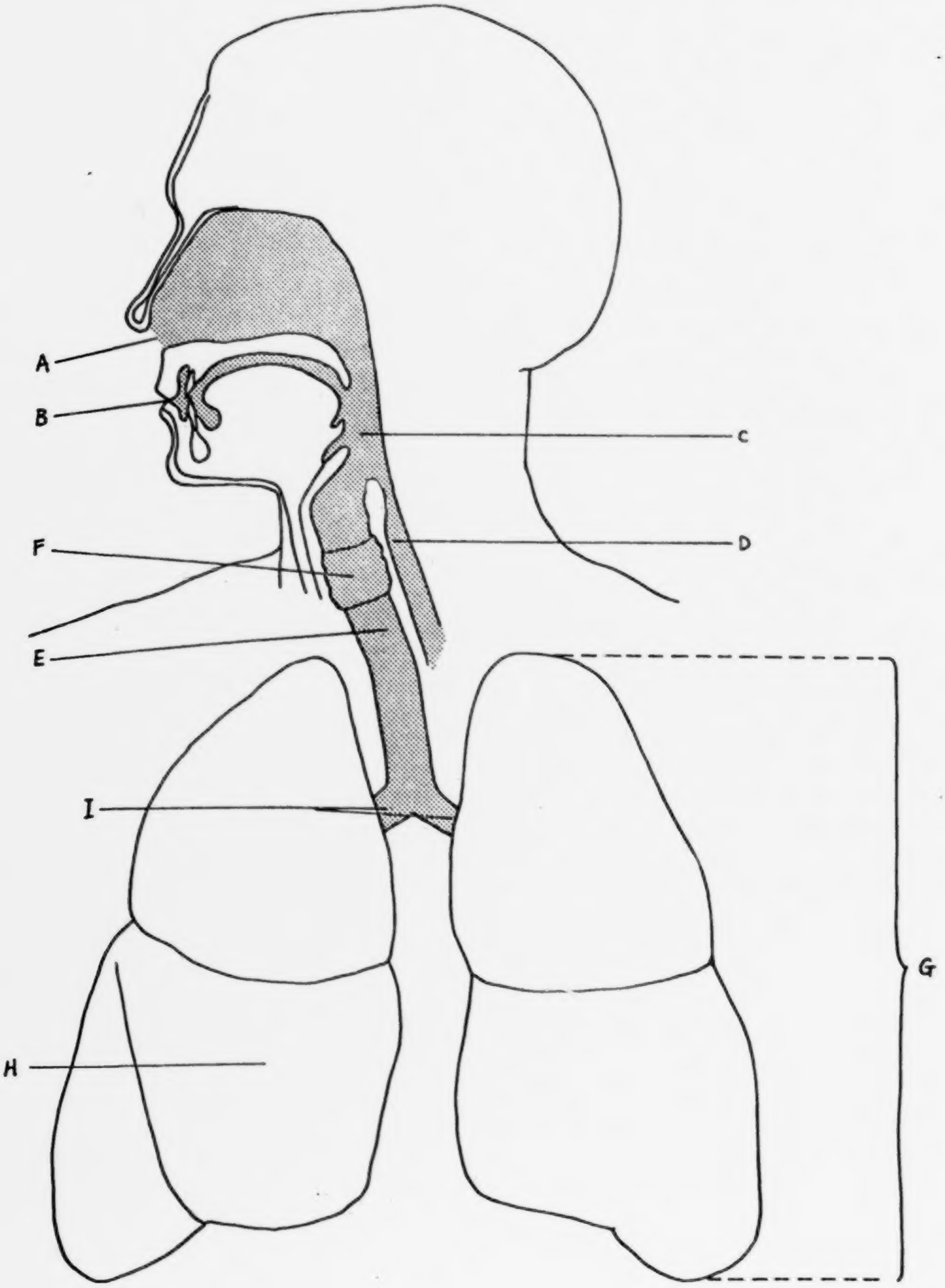
26. PREVIEW FRAME You have seen the path which the blood follows in its passage through the heart. The next section will teach you how the heart causes the blood to follow this path. NO RESPONSE REQUIRED	GO ON TO THE NEXT FRAME
27. REFER BACK TO PANEL 3 The heart is composed mostly of muscle. You would expect, therefore, that the life function performed by this organ is: ☐ contraction ☐ digestion ☐ excretion ☐ irritability	contraction
Suppose the muscle walls surrounding one chamber of the heart, such as the left ventricle, contract. You would expect the space inside the left ventricle to become: ☐ larger ☐ smaller	smaller
Suppose that before contracting the left auricle was full of blood. When the auricle contracts, you would imagine that the blood in it: ☐ would be forced into the next chamber ☐ would remain where it is	would be forced into the next . . .

28.	
REFER TO PANEL 3	
When the left auricle filled with blood contracts, the blood is forced into the left ventricle.	
There are only two openings in the left ventricle; they lead to:	
☐ the aorta ☐ the left auricle ☐ the pulmonary artery ☐ the right auricle ☐ the right ventricle	the aorta the left auricle
Both these openings in the left ventricle, however, are like swinging doors that swing in only one direction -- they allow the blood to flow only one way.	
Knowing the path of the blood through the heart, you know that the opening between the left ventricle and the left auricle allows blood to pass only:	
☐ from auricle to ventricle ☐ from ventricle to auricle	from auricle to ventricle
Similarly, the opening at the beginning of the aorta allows blood to pass only:	
☐ from aorta to ventricle ☐ from ventricle to aorta	from ventricle to aorta
REFER TO PANEL 3. Does it appear that the right auricle and ventricle have openings that work in much the same way as the ones on the left side?	
☐ yes ☐ no	yes

29.	
REFER TO PANEL 3	
The ventricles, like the auricles, work by muscular contraction. When the ventricles fill with blood, they contract, and the blood pours into the:	
☐ aorta	aorta
☐ pulmonary artery	pulmonary artery
☐ veins	
☐ ventricles	
☐ auricles	
The two ventricles fill up at about the same time. The two auricles therefore:	
☐ contract at the same time	contract at the same time
☐ do not contract at the same time	
When the two auricles relax, the two ventricles contract at the same time. The combination of these two separate contractions, each one occurring in two chambers at the same time, is called the heart beat.	
The heart beat refers to:	
☐ the separate contraction of the two chambers of the left side of the heart and the right side of the heart	
☐ **the combined contraction of the two auricles and the two ventricles**	**. . . auricles and ventricles**

30.	
DO NOT REFER TO THE PANEL	
The main life function performed by, the heart is:	
☐ irritability ☐ digestion ☐ contraction ☐ excretion	contraction
The two ventricles contract:	
☐ at the same time ☐ at different times	at the same time
When the ventricles contract blood can flow:	
☐ only into the pulmonary artery or aorta ☐ back into the auricles	only into the pulmonary . . .
31.	
PREVIEW FRAME	
You now know how the heart pushes the blood along, and where the blood goes. You know, for instance, that the blood takes a side trip to the lungs. In a previous lesson you learned that on this side trip the blood loses carbon dioxide and picks up oxygen. In the next section we will look at this connection with the respiratory system in greater detail. First of all, let's see how air is brought into the lungs.	
NO RESPONSE REQUIRED	GO ON TO THE NEXT FRAME

PANEL 5

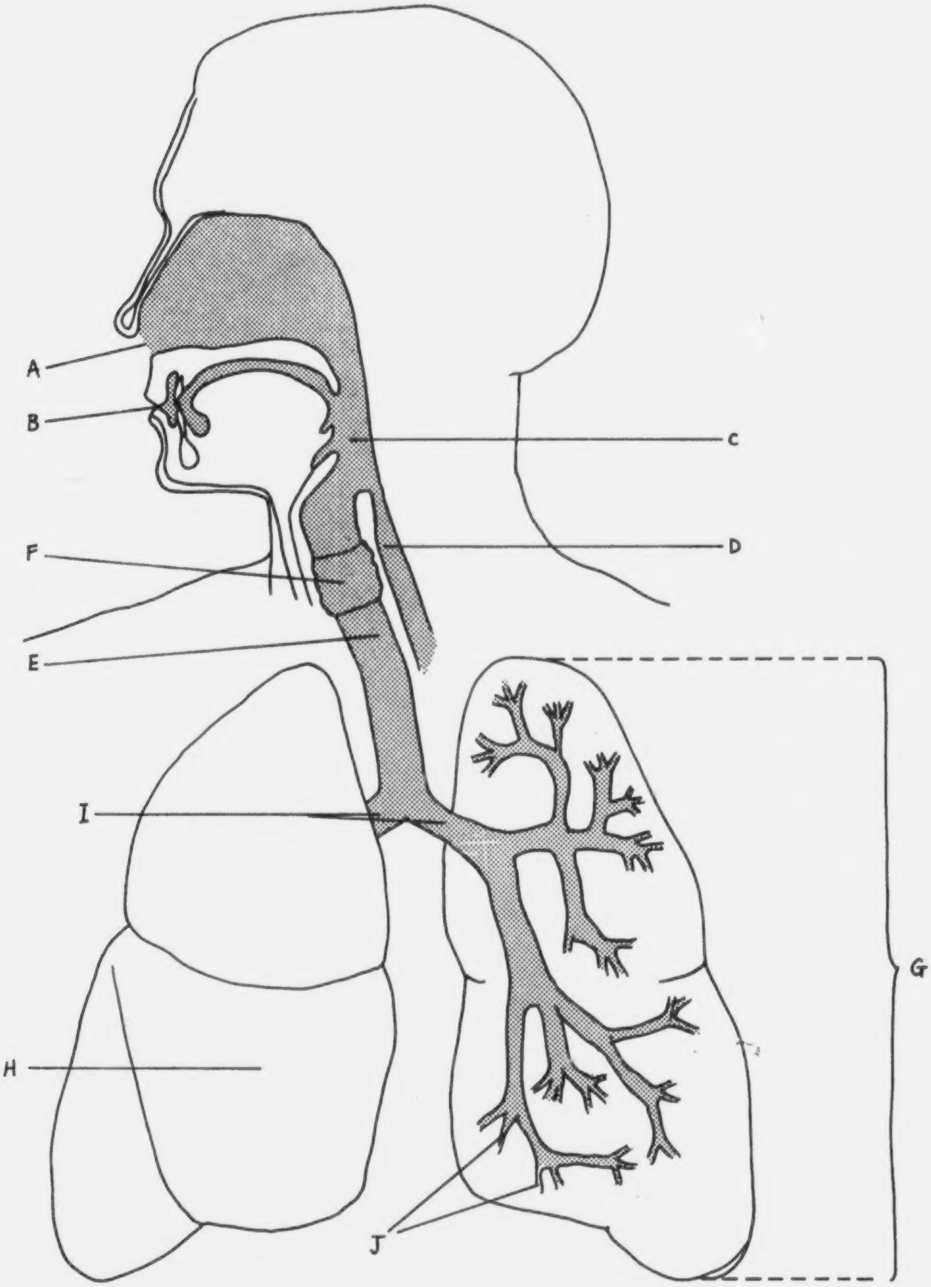


32. REFER TO PANEL 5 The shaded areas on the panel are spaces through which air can pass. From your own experience as well as from the panel you know that air can pass into the body through the: ☐ mouth only ☐ nose only ☐ nose or mouth ☐ neither of the above	nose or mouth
33. REFER TO PANEL 5 As you know, both food going to the stomach and air going to the lungs are carried in a common passageway called the pharynx.* Food passes from the pharynx into a tube that passes it to the stomach. This tube is indicated by the letter D on the panel. The tube that carries food to the stomach is called: ☐ the common duct ☐ the esophagus ☐ the main artery Air going to the lungs passes from the pharynx into a tube that branches off into two tubes just before it reaches the lungs. The passageway for air into the lungs is: ☐ in front of the esophagus ☐ behind the esophagus *Pharynx (far-inks) is Greek for throat.	the esophagus in front of the esophagus

34. The passageway which air follows on its way from the pharynx to the lungs is called the trachea* or the windpipe. REFER TO PANEL 5	
Structure C is the: ☐ esophagus ☐ pharynx ☐ trachea	pharynx
Structure D is the: ☐ esophagus ☐ pharynx ☐ trachea	esophagus
Structure E is the: ☐ esophagus ☐ pharynx ☐ trachea	trachea
*(Tray-key-a)	
35. REFER TO PANEL 5 Between the pharynx and the trachea is a tube-like structure which connects these two organs. This tubular structure contains a pair of muscular folds which regulate the passage of air through it and play a role in the making of voice sounds.	
Does air pass through structure F on the panel? ☐ yes ☐ no	yes
Does food pass through structure F on the panel? ☐ yes ☐ no	no

36. REFER TO PANEL 5 Structure F on the panel is called the larynx.* Because the larynx contains a pair of muscular folds which play a role in the production of sound, it is commonly called the voice box. The larynx is indicated on the panel as a tubular structure on:	
☐ the top of the pharynx ☐ the top of the trachea ☐ the bottom of the trachea	the top of the trachea
Air on its way to the lungs passes:	
☐ from the larynx to the esophagus ☐ from the larynx to the pharynx ☐ through the larynx to the trachea ☐ through the trachea to the pharynx	through the larynx to the trachea
*Larynx (lar-inks)	
37. DO NOT REFER TO THE PANEL NUMBER the structures below from 1 to 4 in the order in which air passes through them on its way to the lungs:	
_____ larynx	3
_____ nose	1
_____ trachea	4
_____ pharynx	2

PANEL 6


A
B
C
D
F
E
G
I
H
J

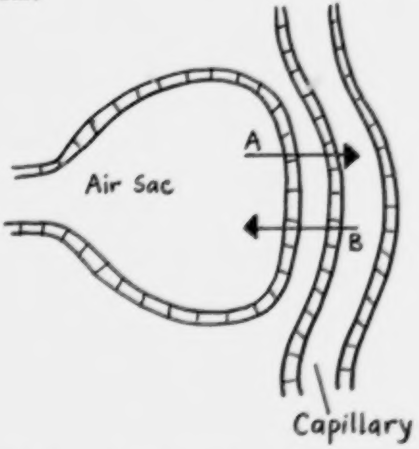
38. REFER TO PANEL 6 The panel shows a schematic drawing of a man facing you. The human body possesses two lungs. Each lung is divided into sections, called lobes. One lung has two lobes, the other three. WRITE the letter of the appropriate structure on the panel in each blank below:	
_____ lobe	H
_____ lung	G
The lung with three lobes is the: ☐ left lung ☐ right lung	right lung
Structure E is the tube which air enters after passing through the larynx. E indicates the: ☐ esophagus ☐ trachea ☐ vocal box	trachea
39. REFER TO PANEL 6 When you breathe in, air: ☐ enters the lungs ☐ leaves the lungs	enters the lungs
As you know, the trachea divides into two branches, each one of which goes into one lung. At the point where the trachea divides into two tubes, one leading into each of the lungs, it is known as the bronchi.* Do the bronchi branch off into smaller tubes? ☐ yes ☐ no	yes
*Bronchi (bron-key)	

40.	
REFER TO PANEL 6	
The smallest branches of the bronchi are called the bronchioles.*	
WRITE the letter of the appropriate structure on the panel in each blank below:	
_____ bronchi	I
_____ bronchiole	J
*Bronchioles (bron-key-oles)	
41.	
NUMBER the structures below from 1 to 5 in the order in which air passes through them as you breathe in:	
_____ bronchi	5
_____ bronchiole	6
_____ larynx	3
_____ nose	1
_____ trachea	4
_____ pharynx	2

42.	
REFER TO PANEL 6	
MATCH the structures in the panel to the terms below by writing one letter in each blank:	
_____ esophagus	D
_____ pharynx	C
_____ mouth	B
_____ nose	A
_____ trachea	E
_____ larynx	F
_____ lobes	H
_____ lungs	G
_____ bronchi	I
_____ bronchioles	J
43.	
REVIEW FRAME	
The body uses: ☐ oxygen ☐ carbon dioxide	oxygen
A waste product of the body's energy-producing reaction is: ☐ oxygen ☐ carbon dioxide	carbon dioxide

44.	
This exchange of oxygen and carbon dioxide takes place in the lungs.	
Thus, air that leaves the lungs will contain:	
☐ more oxygen than when it entered	
☐ less oxygen than when it entered	less oxygen than when it entered
☐ more carbon dioxide than when it entered	more carbon dioxide than . . .
☐ less carbon dioxide than when it entered	
The blood which has come to the lungs from the pulmonary artery will contain:	
☐ more oxygen when it enters the left auricle	more oxygen when it enters . . .
☐ less oxygen when it enters the left auricle	
☐ more carbon dioxide than when it left the right ventricle	
☐ less carbon dioxide than when it left the right ventricle	less carbon dioxide than . . .
The lungs:	
☐ provide the blood with carbon dioxide	
☐ provide the blood with oxygen	provide the blood with oxygen
☐ take carbon dioxide from the blood	take carbon dioxide from . . .
☐ take oxygen from the blood	

45.	
Air that has been breathed in passes the bronchioles into tiny bags or sacs that are only one cell in thickness. These tiny air sacs are surrounded by capillaries.	
The blood in the capillaries surrounding the air sacs has come from the:	
☐ aorta	
☐ pulmonary artery	pulmonary artery
Air that enters the air sacs:	
☐ goes back into the bronchioles	goes back into the bronchioles
☐ remains in the air sacs	
At the point when you breathe in you would expect the air in your air sacs to have:	
☐ more oxygen than the blood in the capillaries surrounding them	more oxygen that the blood . . .
☐ less oxygen than the blood in the capillaries surrounding them	
☐ more carbon dioxide than the blood in the capillaries surrounding them	
☐ less carbon dioxide than the blood in the capillaries surrounding them	less carbon dioxide than the . . .

46. The walls of capillaries and the air sacs they surround are so thin that carbon dioxide and oxygen can easily pass through them.	
	
In the above diagram, oxygen would pass in the direction of arrow: ☐ A ☐ B	A
Carbon dioxide would pass in the direction of arrow: ☐ A ☐ B	B
In chemistry you learned that gases will pass through a membrane to a place of less concentration. Oxygen passes from oxygen rich air to oxygen poor blood; carbon dioxide passes from carbon dioxide rich blood to carbon dioxide poor air.	

47.

Carbon dioxide follows the same passageways to leave the body that oxygen followed to enter the body.

NUMBER the following structures from 1 to 7 in the order in which carbon dioxide passes through them on its way to the nose:

_____ air sac	2
_____ bronchi	4
_____ bronchiole	3
_____ capillary wall	1
_____ larynx	6
_____ nose	8
_____ trachea	5
_____ pharynx	7

48.	
Blood from the lungs re-enters the heart at the left auricle and is then pumped from the left ventricle to different parts of the body. Such blood will have:	
☐ little carbon dioxide	little carbon dioxide
☐ little oxygen	
☐ much carbon dioxide	
☐ much oxygen	much oxygen
This blood is carried by the arteries and capillaries to the tissues of the body. Oxidation occurs in the cells of the tissues. The capillaries:	
☐ supply carbon dioxide to the cells	
☐ supply oxygen to the cells	supply oxygen to the cells
☐ take carbon dioxide away from the cells	take carbon dioxide away . . .
☐ take oxygen away from the cells	
By the time the blood returns from the body's parts to the right auricle it will have:	
☐ less oxygen than when it left the left auricle	less oxygen than when it left . . .
☐ more oxygen than when it left the left auricle	
☐ less carbon dioxide than when it left the left auricle	
☐ more carbon dioxide than when it left the left auricle	more carbon dioxide than . . .

49.

DESCRIBE the oxygen: carbon dioxide ratios in blood at various points by writing two letters in the blanks following each number below:

A. high oxygen content

B. low oxygen content

C. high carbon dioxide content

D. low carbon dioxide content

______:______ blood entering the lung capillaries	B, C
______:______ air entering the lungs	A, D
______:______ blood leaving the lung capillaries	A, D
______:______ air leaving the lungs	B, C
______:______ blood returning to the heart from the body's parts	B, C
______:______ blood leaving the heart going to the body's parts	A, D

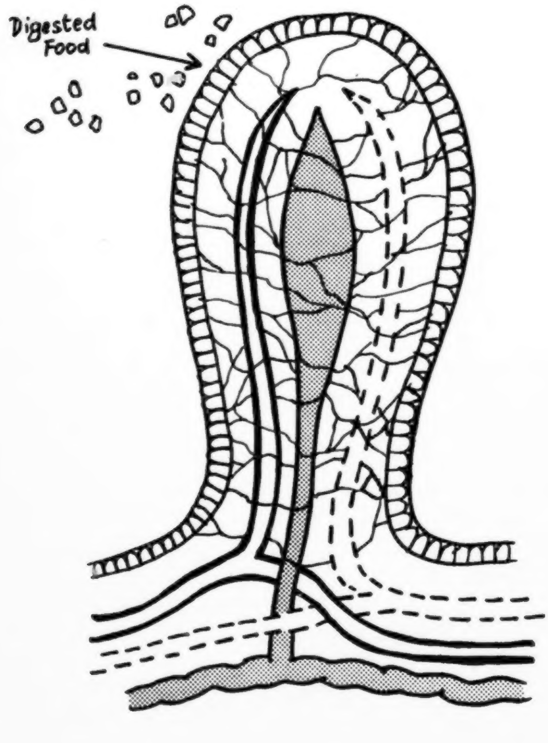
50.

PREVIEW FRAME

You have learned how the respiratory system supplies oxygen to the blood and removes carbon dioxide from it. This occurs on the blood's "side trip" to the lungs. We can now return to the circulatory system. In the next section you will learn how digested food enters the blood through the villi of the small intestine.

NO RESPONSE REQUIRED	GO ON TO THE NEXT FRAME

PANEL 7


Digested Food

51.	
REFER TO PANEL 7	
The panel shows one of the millions of villi in the small intestine. Each villus contains three types of tubes. The tube with a wall of broken lines represents the arteriole carrying blood to the villus. The tube with a wall of solid lines represent the veinule carrying blood from the villus. The shaded tube is a structure that collects digested fats separately from the blood.	
The tube shown running up the right-hand side of the villus:	
☐ has obtained the digested food ☐ has not yet obtained the digested food	has not yet obtained the . . .
The tube shown running up the left-hand side of the villus:	
☐ has obtained the digested food ☐ has not yet obtained the digested food	has obtained the digested food
The tube shown at the center of the villus carries:	
☐ amino acids ☐ glycose ☐ glycerine ☐ fatty acids	glycerine fatty acids
This tube:	
☐ is an arteriole ☐ is a veinule ☐ is neither of the above	is neither of the above

52.	
REFER TO PANEL 7	
The tube shown at the center of the villus is called a lymph vessel.* The lymph vessel picks up:	
☐ carbohydrates	
☐ lipids	lipids
☐ proteins	
The arterioles of the villi are linked to the vein by the capillaries. From earlier sections of this lesson, you would expect that digested food enters the blood through the walls of the:	
☐ arterioles	
☐ capillaries	capillaries
☐ veinules	
You would expect that the major part of the food taken up by the capillaries consists of (CHECK two):	
☐ carbohydrates	carbohydrates
☐ lipids	
☐ proteins	proteins
*Lymph is body water.	
53.	
DO NOT REFER TO THE PANEL	
CHECK below the structure(s) found in each villus:	
☐ arteriole	arteriole
☐ bronchiole	
☐ capillary	capillary
☐ sac	
☐ lymph vessel	lymph vessel
☐ veinule	veinule
☐ ventricle	

54.

DO NOT REFER TO THE PANEL

MATCH the terms below to the description of their function in the villi, by writing one letter in each blank:

A. arteriole

B. capillary

C. lymph vessel

D. veinule

_____ accept mostly digested proteins and carbohydrates through its walls	B
_____ collects digested lipids	C
_____ carries blood to the villi	A
_____ carries blood from the villi	D

55.

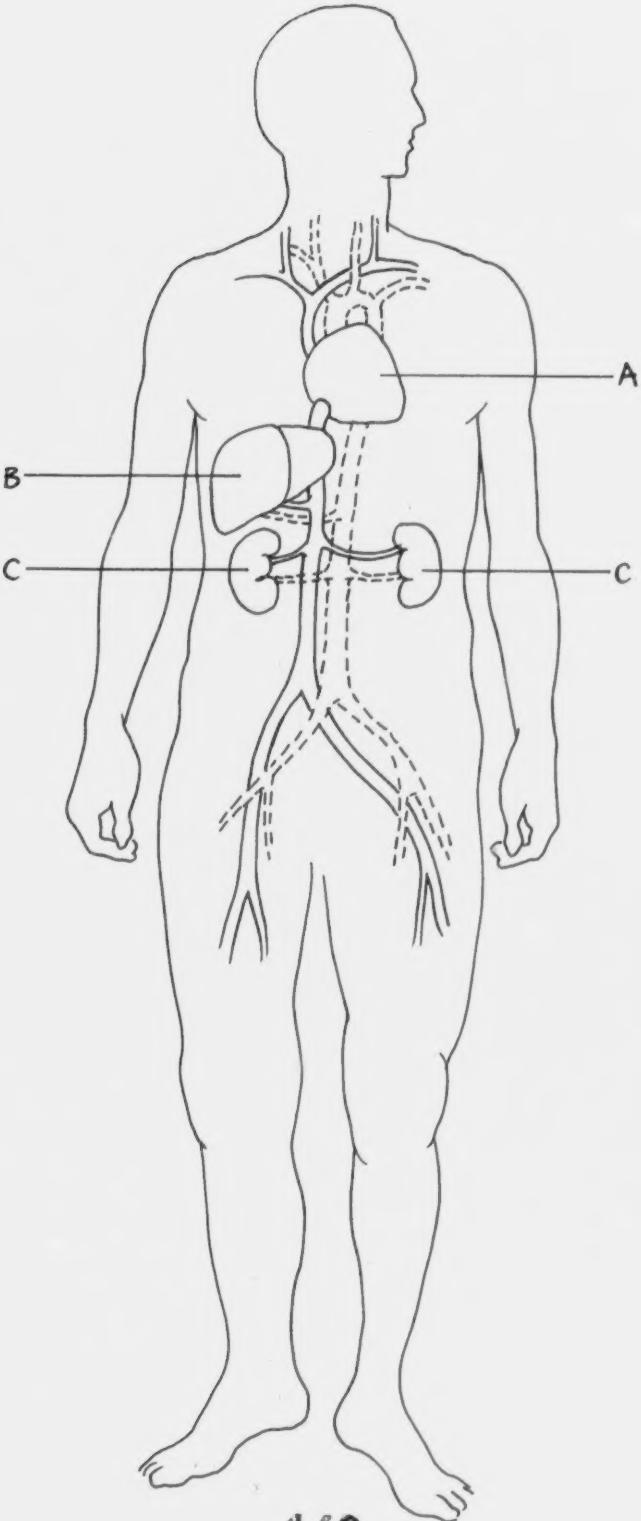
PREVIEW FRAME

In a previous lesson you learned how the liver functions as part of the digestive system. The liver may also be thought of as an organ associated with the circulatory system. Another important organ -- actually a pair of organs -- is associated with the circulatory system. In the next section you will learn how these organs affect the circulating blood.

NO RESPONSE REQUIRED

GO ON TO THE NEXT FRAME

PANEL 8



56.	
REFER TO PANEL 8	
The panel shows a part of the liver and a pair of bean-shaped organs which function to rid the blood of waste materials. These bean-shaped organs are called the kidneys.	
The letter B is pointing to a structure known as the:	
☐ kidneys	
☐ liver	liver
The letter C is pointing to a structure known as the:	
☐ kidney	kidney
☐ liver	
Arteries in the panel are marked with dotted lines, veins with solid lines.	
The liver is connected to the:	
☐ arteries	arteries
☐ veins	veins
The kidneys are connected to the:	
☐ arteries	arteries
☐ veins	veins
57.	
REFER TO PANEL 8	
The two bean-shaped structures on the panel remove waste material in liquid form from the blood. This waste material is called urine.*	
Waste materials, called urine, are removed from the blood in:	
☐ the kidneys	the kidneys
☐ the liver	
*Urine (your-in) from the Greek word for water.	

58.	
MATCH the terms below to the description of their function by writing one letter in each blank:	
A. kidneys B. liver	
_____ receives digested food materials from the small intestine, metabolizes carbohydrates, lipids and proteins which are carried by the blood to parts of the body where they are needed	B
_____ takes waste material called urine from the blood	A
59.	
The network of blood vessels that circulates through the liver is called the hepatic* portal system. The network of blood vessels that circulates through the kidneys is called the renal** portal system.	
After the blood leaves the hepatic portal system, it will contain:	
☐ a new supply of metabolized carbohydrates, lipids, and proteins	a new supply of . . .
☐ less waste materials	
After the blood leaves the renal portal system, it will contain:	
☐ a new supply of metabolized carbohydrates, lipids, and proteins	
☐ less waste materials	less waste materials
*Hepatic, from Greek for liver. **Renal, from Latin for kidney.	

60.	
The hepatic portal system is connected with the: ☐ kidneys ☐ liver	liver
The renal portal system helps to: ☐ remove wastes from the blood ☐ remove excess glucose from the blood for storage	remove wastes from the blood
61.	
DO NOT REFER TO THE PANEL	
MATCH the organs to their descriptions by writing one letter in each blank:	
A. renal portal system B. hepatic portal system	
_____ refers to the liver	B
_____ refers to the kidneys	A
_____ stores digested carbohydrates	B
_____ removes wastes from blood	A
	Time completed _____________

YOU HAVE NOW FINISHED THE FIRST PART OF THIS LESSON. WRITE DOWN THE TIME. THEN, AFTER YOU HAVE REVIEWED THE MAIN IDEAS IN THE FOLLOWING SUMMARY, TAKE THE MASTERY TEST AT THE END OF THE BOOKLET.

The main parts of the circulatory system are the heart, the arteries (the smallest branches of which are called the arterioles), the veins (the smallest branches of which are called the venules), and the capillaries (which are minute vessels connecting the arterioles with the venules.	The human heart is a four-chambered muscular organ that acts like a pump for the body's blood. The two upper chambers are called auricles; the two lower chambers are called ventricles.
The circulation of the blood after it leaves the left side of the heart.	Blood flows from the heart through the arteries and arterioles and then the capillaries. Because the capillaries are very thin vessels, digested food materials and oxygen pass through the walls of the capillaries to the body's cells. Waste products and carbon dioxide enter the capillaries which empty into the venules and larger veins that carry the blood back to the heart.
CIRCULATION OF THE BLOOD THROUGH THE HEART	
RIGHT AURICLE	receives blood from the body's parts and pumps it to the right ventricle.
RIGHT VENTRICLE	pumps blood through the pulmonary artery to the lungs.
LEFT AURICLE	receives blood from the lungs via the pulmonary vein and pumps blood to the left ventricle.
LEFT VENTRICLE	pumps blood through the aorta to the body's parts.
THE HEARTBEAT	By contracting, the heart's muscles first force the blood out of the auricles and then out of the ventricles. The contraction of the auricles and the ventricles is the heartbeat.
THE MAIN PARTS OF THE RESPIRATORY SYSTEM ARE:	
MOUTH AND NOSE	are openings through which air enters the body.
PHARYNX	is the common passageway for food and air.
LARYNX	connecting the pharynx and the trachea the larynx contains a pair of muscular folds which regulate the passage of air through it and play a role in the production of sound.

THE TRACHEA	is the air passageway leading into the bronchi.
THE BRONCHI	are the air passageways leading into the lungs. The bronchi branch off into smaller tubes called bronchioles.
AIR SACS	are found at the end of the bronchioles. Oxygen passes from the air sacs to the capillaries surrounding them and carbon dioxide passes from the capillaries to the air sacs. Carbon dioxide follows the same route, but in reverse, that oxygen follows into the body.
THE LUNGS	2 lobular organs in which the exchange of carbon dioxide and oxygen takes place.
THE OXYGEN AND CARBON DIOXIDE CONTENT OF THE BLOOD BEFORE AND AFTER LEAVING THE LUNGS	Blood being pumped from the right ventricle to the lungs has more carbon dioxide and less oxygen than blood reentering the left auricle of the heart.
CIRCULATION THROUGH THE LINING OF THE SMALL INTESTINE	Blood flowing into the veinules in the villi receives digested food material absorbed from the small intestine.
THE HEPATIC PORTAL SYSTEM	Blood circulating through the liver picks up a new supply of metabolized carbohydrates, lipids, and proteins.
THE RENAL PORTAL SYSTEM	Waste material is removed from the blood when it circulates through the kidneys.

MASTERY TEST

Time started ______________

1. CHECK the true statement(s) below:

   a. ☐ Blood flows from the arterioles to the veins to the venules.

   b. ☐ Blood flows from the capillaries to the arterioles to the arteries.

   c. ☐ Blood flows from the capillaries to the venules to the veins.

   d. ☐ Blood flows from the veins to the venules to the capillaries.

2. Blood goes to the lungs from the:

   a. ☐ right auricle

   b. ☐ right ventricle

   c. ☐ aorta

   d. ☐ left auricle

3. Blood flowing through the heart passes from:

   a. ☐ auricle to ventricle

   b. ☐ ventricle to auricle

   c. ☐ auricle to vein

   d. ☐ artery to ventricle

4. By CHECKING one or more statements below, COMPARE the oxygen and carbon dioxide content of the blood flowing from the arterioles to the capillaries and from the capillaries to the venules in the lungs.

   a. ☐ The blood in the venules will have more carbon dioxide.

   b. ☐ The blood in the arterioles will have more carbon dioxide.

   c. ☐ The blood in the arteriole will have more oxygen.

   d. ☐ The blood in the venules will have more oxygen.

5. The renal portal system helps to:

   a. ☐ remove wastes from the blood

   b. ☐ remove excess glucose from the blood for storage

   The hepatic portal system is connected with:

   a. ☐ the kidneys

   b. ☐ the liver

Time completed ________________

WHEN YOU HAVE FINISHED THIS TEST, WRITE DOWN THE TIME. THEN TAKE THE LESSON TO YOUR INSTRUCTOR OR HIS ASSISTANT FOR CHECKING. WAIT UNTIL THE LESSON IS APPROVED BEFORE GOING ON TO THE NEXT LESSON.

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ADVANCED
GENERAL EDUCATION PROGRAM

A HIGH SCHOOL SELF-STUDY PROGRAM

REPRODUCTION OF A SINGLE CELL

LEVEL: III
UNIT: 3
LESSON: 5

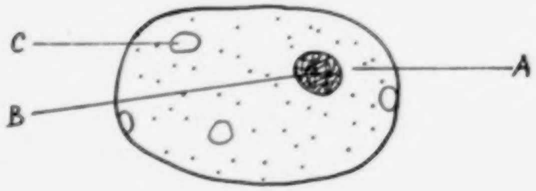
U.S. DEPARTMENT OF LABOR
MANPOWER ADMINISTRATION, JOB CORPS
NOVEMBER 1969

U.S. DEPARTMENT OF LABOR
MANPOWER ADMINISTRATION, JOB CORPS
NOVEMBER 1969

1. PREVIEW FRAME All organisms produce offspring like themselves. This way of preserving the different types of organisms is made possible because cells can themselves produce offspring. In the next lesson you will learn the two basic processes by which cells reproduce themselves. You will also learn how one of these processes helps complex, multicellular organisms to produce offspring. NO RESPONSE REQUIRED	GO ON TO THE NEXT FRAME
2. Giraffes produce offspring which have long necks. Elephants have babies which possess trunks. The offspring of tigers have stripes on their hides. From these examples you can see that each type of organism gives rise to an offspring which is basically: ☐ like itself ☐ unlike itself	like itself

3. The basic features of each organism, including its characteristic shape, size, color, and activities, are determined by a set of structures found in every cell of that organism. The determining features of an apple are found: ☐ in all the cells of the apple tree ☐ only in the cells of the apple ☐ only in certain cells of the tree The objects that determines the size of a monkey's tail or the shape of his hands are found: ☐ only in certain cells of the monkey's body ☐ in each cell of the monkey's body	in all the cells of the apple tree in each cell of the monkey's body
4. The cellular structures which determine the characteristics of any organism influence: ☐ the coloring of the organism ☐ the general shape of the organism ☐ the functions and activities of the organism	the coloring of the organism the general shape of the . . . the functions and activities . . .

5.



The determinents of characteristics of any organism are formed from the chromatin in each cell of the organism.

In the drawing of a cell above the chromatin is labelled B.

Chromatin is best described as:

- ☐ a mass of tangled thread-like material
- ☐ a storage space in the cytoplasm of the cell
- ☐ a small round body lying near the nucleus of the cell

The structures which determine the characteristics of an organism are found:

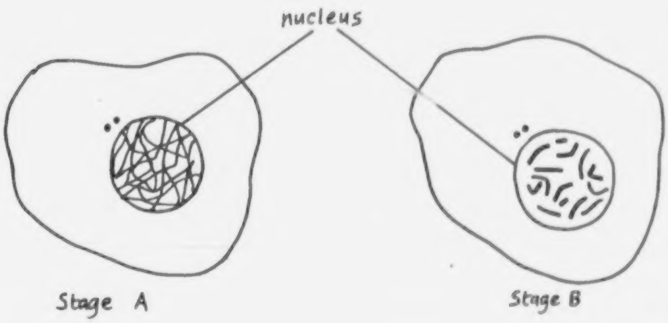
- ☐ in the cytoplasm of the organism's cells
- ☐ in the nucleus of an organism's cells
- ☐ in the vacuoles of an organism's cells

a mass of tangled . . .

in the nucleus of an . . .

6.

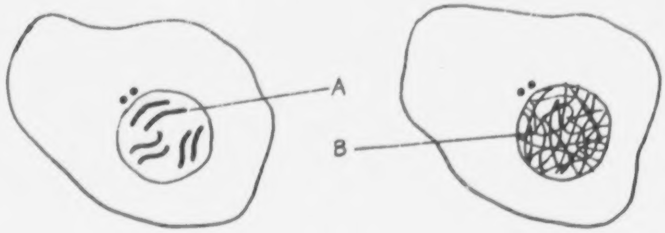
You recall from an earlier lesson that most of the nucleus of a cell is composed of a mass of tangled threads, called chromatin. At a certain stage in a cell's life, these threads shorten and thicken to become distinct structures. At this point the material is no longer referred to as chromatin.



Above are shown two stages in a cell's life. In which stage is the substance filling most of the nucleus no longer called chromatin?

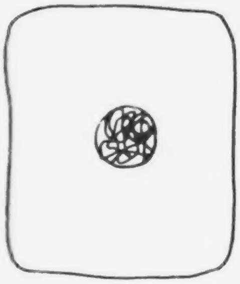
☐ stage A
☐ stage B

stage B

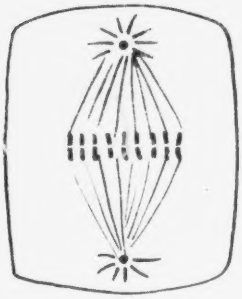
7. The distinct structures which appear in the nucleus at a certain stage in the cell's life are called chromosomes. IDENTIFY the structures below by writing one letter in each blank:	
	
1. _____ chromatin	1. B
2. _____ chromosomes	2. A
Chromosomes are structures which:	
☐ may be found in all the cells of an organism at a certain stage	may be found in all the cells . . .
☐ may be found in only some of the cells of an organism	
☐ determine the characteristics of an organism	determine the . . .
☐ only determine the colors of an organism	

8.	
Chromosomes are cellular structures which:	
☐ are found in the nucleus of a cell at a certain stage	are found in the nucleus . . .
☐ may be found in the nucleus of only certain cells in the organism	
☐ are found in the cytoplasm of only certain cells in the organism	
☐ determine the characteristics of any organism	. . . of any organism
☐ determine the characteristics of animal organisms only	
☐ are formed from the chromatin found in the nucleus of a cell	are formed from the . . .
☐ have distinct shapes	have distinct shapes
9.	
PREVIEW FRAME	
You have learned that the basic characteristics of an organism are determined by the chromosomes found in the nucleus of each cell of the organism.	
In the following section you will learn how the characteristics of an organism are passed on to its offspring in the process of reproduction.	
We will begin by considering reproduction as it occurs in cells.	
NO RESPONSE REQUIRED	GO ON TO THE NEXT FRAME

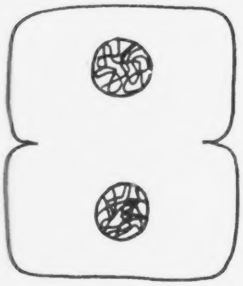
PANEL 1



1.



2.



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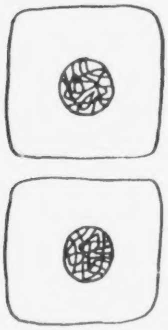


4.

10.	
REFER TO PANEL 1	
Figures 1 - 4 in Panel 1 represent a sequence in which one cell splits into two separate cells.	
In the process of splitting:	
☐ both the cytoplasm and nucleus of the original cell divide into two parts	both the cytoplasm . . .
☐ only the cytoplasm of the original cell divides into two parts	
☐ only the nucleus of the original cell divides into two parts	
Each of the two cells which result from the splitting of the original cell:	
☐ is larger than the original cell	
☐ is smaller than the original cell	is smaller than the . . .
☐ is the same size as the original cell	
The cells which result from the process of splitting:	
☐ differ in appearance from the original cell	
☐ are similar in appearance to the original cell	are similar in appearance . . .

11.	
REFER TO PANEL 1	
Figures 1 - 4 in Panel 1 represent a type of cell division in which the original, or mother cell, divides into two daughter cells.	
Which of the figures in Panel 1 represent(s) the mother cell before splitting begins? ________	1
Which of the figures represent(s) the daughter cells? ________	4
The daughter cells are smaller than the mother cell, but have the same basic characteristics as the mother cell.	
You could guess that the set of chromosomes in one daughter cell is:	
☐ different from the set in the other daughter cell ☐ different from the set in the mother cell ☐ like the set in the mother cell ☐ like the set in the other daughter cell	like the set in the mother cell like the set in the other . . .

12.

REFER TO PANEL 1

The figures in Panel 1 illustrate a type of cell division known as mitosis or mitotic division. Mitosis means thread; when you cut a thread, you have two smaller threads.

Which of the following statements correctly describe mitotic division?

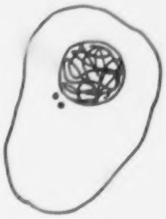
☐ One cell splits and produces two new cells.	One cell splits and . . . .
☐ Two cells join and produce two new cells.	
☐ Each of the new cells has the same basic characteristics as the original cell.	Each of the new cells . . . .
☐ Each of the new cells has characteristics different than the mother cell.	
☐ The set of chromosomes in each daughter cell is unlike the set in the mother cell.	
☐ The set of chromosomes in one daughter cell is like the set of chromosomes in the other daughter cell.	. . . is like the set of . . . .
☐ Both the cytoplasm and nucleus of the mother cell split and form two daughter cells.	Both the cytoplasm . . . .
☐ Only the cytoplasm of the mother cell divides into two parts.	

13.	
As a result of the process of mitotic division one cell is divided into two cells which have the same basic characteristics as the original cell.	
Furthermore, each new, or daughter cell, has a set of chromosomes which exactly resembles the set of chromosomes in the mother cell.	
A cell with three pairs of chromosomes divides, mitotically, into two cells:	
☐ each of which has three chromosomes	
☐ each of which has six chromosomes	. . . six chromosomes
☐ one of which has twice as many chromosomes as the other	
14.	
Mitosis is a process of cellular reproduction in which:	
☐ one cell divides into two cells each of which has the same number of chromosomes as the original cell	one cell divides into . . .
☐ two cells join and produce new cells	
☐ each daughter cell has twice the number of chromosomes as the original cell	
☐ the daughter cells have the same basic characteristics as the mother cell	the daughter cells have . . .
☐ the daughter cells have characteristics different than the mother cell	

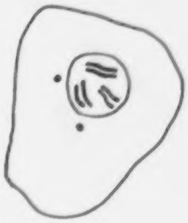
15. PREVIEW FRAME You have learned that mitosis is a type of cell division in which each of the daughter cells has the same basic characteristics and the same number of chromosomes as the original mother cell. In the following section you will learn about some of the important details in the process of mitotic division. NO RESPONSE REQUIRED	GO ON TO THE NEXT FRAME
16. Mitosis is a continuous process but it is best studied in four successive stages. In the first stage, the indistinct curly threads within the nucleus become distinct rod-like structures. In other words, in the first stage of mitosis: ☐ the mother cell splits into two daughter cells ☐ the chromosomes become chromatin ☐ the chromatin becomes chromosomes	the chromatin . . .

17.

You recall from an earlier lesson that animal cells contain two small bodies lying together near the nucleus, called centrioles.* As the chromatin forms itself into chromosomes, the centrioles move apart. Which of the following cells illustrates the first stage of mitosis?



☐ A



☐ B

In the first stage of mitosis, the structures which become distinct within the nucleus are:

☐ centrioles
☐ chromosomes
☐ vacuoles

The structures which separate from one another outside the nucleus are:

☐ centrioles
☐ chromosomes
☐ daughter cells

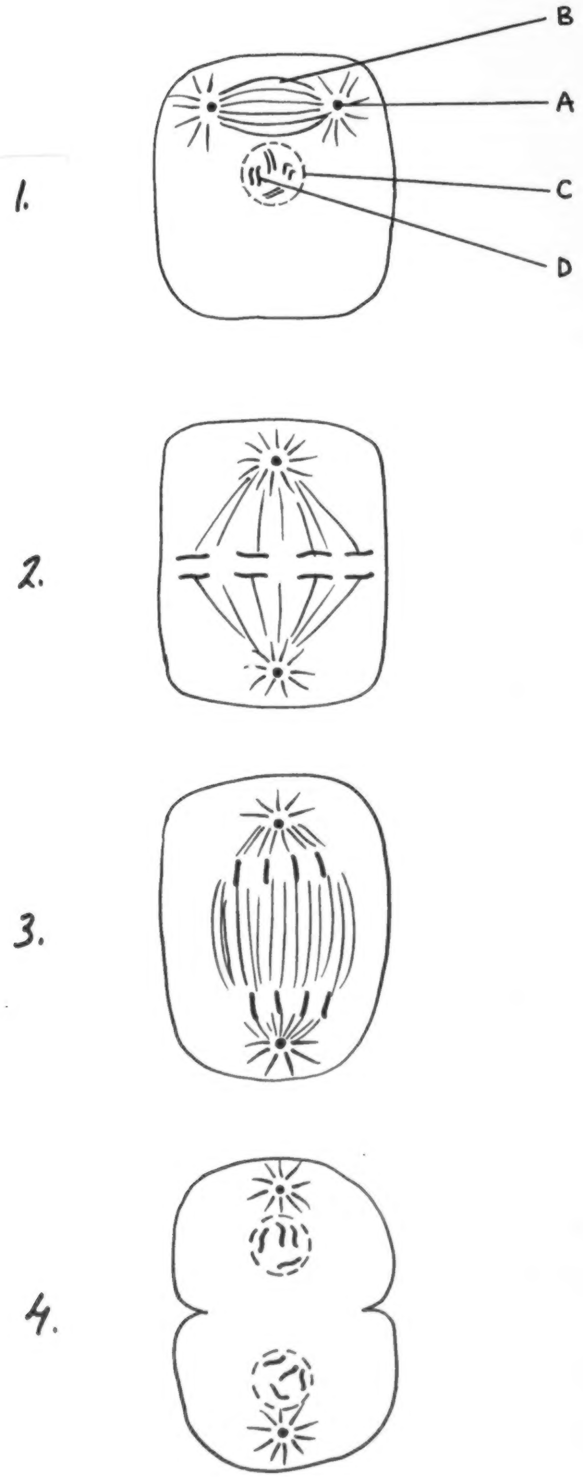
*Centriole means (centri-) near the center and (-ole) very small.

B

chromosomes

centrioles

PANEL 2



18.	
REFER TO PANEL 2	
As the centrioles separate in the first stage of mitosis, star-shaped structures form around each centriole. Long fibers form between the two centrioles.	
In the panel, these long fibers are labeled with the letter _____.	B
The star-shaped structures are indicated by the letter _____.	A
19.	
REFER TO PANEL 2	
The letter A in the panel indicates structures called asters.* The letter B indicates structures called spindle fibers.	
MATCH the following terms to their descriptions by writing one letter in each blank:	
A. asters B. spindle fibers	
1. _____ long threads between the centrioles	1. B
2. _____ star-shaped structures	2. A
3. _____ two are formed	3. A
4. _____ form around the centrioles	4. A
*Aster means star as in astronomy.	

20. REFER TO PANEL 2 Two other events occur in the first stage of mitosis: the nuclear membrane disappears, and each chromosome duplicates itself.	
In the panel the disappearance of the nuclear membrane is indicated by the letter _____.	C
The doubled chromosomes are indicated by the letter _____.	D
By the end of the first stage of mitosis, would you expect that the cell nucleus is as easy to distinguish within the cell as before mitosis? ☐ yes ☐ no	no
Suppose a cell of a certain type of organism contains 46 chromosomes. By the end of the first stage of mitosis, it would contain: ☐ 23 chromosomes ☐ 46 chromosomes ☐ 92 chromosomes	92 chromosomes

21.

DO NOT REFER TO THE PANEL

Which of the following are events occurring during the first stage of mitosis ?

☐ Centrioles are formed.	
☐ Asters are formed.	Asters are formed.
☐ The centrioles move apart.	The centrioles move apart.
☐ The centrioles move together.	
☐ The cell wall disappears.	
☐ The nuclear membrane disappears.	The nuclear membrane disappears.
☐ The spindle fibers appear.	The spindle fibers appear.
☐ The spindle fibers disappear.	
☐ The chromosomes turn into chromatin.	
☐ The chromatin turns into chromosomes.	The chromatin turns into . . .
☐ The chromosomes become doubled.	The chromosomes become . . .
☐ The chromatin becomes doubled.	

22. REFER TO PANEL 2 By the end of the first stage of mitosis, the asters have moved to opposite ends of the cell. In the second stage, the chromosomes begin to arrange themselves in a pattern. They lineup in a position: ☐ near one of the asters ☐ near the cell wall ☐ half-way between the asters	half-way between the asters
In the second stage the doubled chromosomes: ☐ move closer together ☐ begin to separate from each other ☐ disintegrate	begin to separate from each other
23. DO NOT REFER TO THE PANEL LABEL the following events that occur within the process of mitosis with the letter representing the appropriate stage. A. first stage B. second stage	
1. _____ asters are formed	1. A
2. _____ chromosomes line up halfway between the asters	2. B
3. _____ chromosomes double	3. A
4. _____ centrioles move apart	4. A
5. _____ chromatin is formed into chromosomes	5. A
6. _____ the doubled chromosomes begin to separate	6. B
7. _____ the nuclear membrane disappears	7. A

24.	
REFER TO PANEL 2	
In the third stage of mitosis, one chromosome from each of the pair of chromosomes in the set moves towards one aster, the other chromosome of the pair moves towards the other aster.	
Suppose the mother cell has four chromosomes before the beginning of mitosis. How many chromosomes would be present in the third stage of mitosis? _____	eight
By the end of the third stage of mitosis there would be:	
☐ eight chromosomes near each aster	
☐ four chromosomes near each aster	four chromosomes near each aster
☐ eight chromosomes near one aster and none near the other	

25.	
REFER TO PANEL 2	
Does the cell have an identifiable nucleus in the second stage of mitosis ?	
☐ yes	
☐ no	no
Does it have an identifiable nucleus in the third stage ?	
☐ yes	
☐ no	no
At the end of the third stage, each aster has near it:	
☐ half the number of chromosomes the mother cell had before mitosis	
☐ the same number of chromosomes the mother cell had before mitosis	the same number of . . .
☐ half the full number of chromosomes the mother cell had before mitosis	
If two new cells are to be created, you would guess that their nuclei will be formed:	
☐ where the old nucleus was	
☐ at the center of the cell	
☐ around the asters with their groups of chromosomes	around the asters with . . .
26.	
DO NOT REFER TO THE PANEL	
In the third stage of mitosis, the halves of the doubled chromosomes:	
☐ come together	
☐ separate	separate
☐ move to the center of the cell	
☐ move to the asters	move to the asters

27.	
REFER TO PANEL 2	
From the panel what can you say about nuclear membranes in the fourth stage of mitosis?	
☐ A nuclear membrane disappears.	
☐ Two nuclear membranes disappear.	
☐ A nuclear membrane appears.	
☐ Two nuclear membranes appear.	Two nuclear membranes appear.
From the panel you can see that the cell contained evidences of one or more nuclear membranes during which stage(s) of mitosis?	
☐ First stage	First stage
☐ Second stage	
☐ Third stage	
☐ Fourth stage	Fourth stage
In the fourth stage, how many nuclei are forming?	
☐ one	
☐ two	two
☐ four	

28.

REFER TO PANEL 2

In the fourth stage of mitosis, the structures which linked the chromosomes to the asters disappear. The asters also disappear, leaving behind the centrioles. Also, the distinct rod-like structures that carry genes turn back into the find, curly threads that compose most of the nucleus.

On the basis of these facts, COMPLETE the table below by CHECKING the appropriate boxes:

	appear(s) in fourth stage	disappear(s) in fourth stage	appear(s) in fourth stage	disappear(s) in fourth stage
chromosomes	☐	☐	☐	☒
chromatin	☐	☐	☒	☐
asters	☐	☐	☐	☒
nuclear membranes	☐	☐	☒	☐
nuclei	☐	☐	☒	☐
spindle fibers	☐	☐	☐	☒

29.

REFER TO PANEL 2

Asters and spindle fibers appear in stage:

- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4

1

They disappear in stage:

- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4

4

30.

REFER TO PANEL 2

If, after the nuclear membranes were formed in the fourth stage, nothing further happened, the cell would contain: ☐ 1 nucleus ☐ 2 nuclei ☐ 4 nuclei	2 nuclei
However, in the fourth stage, the cell wall pinches inward across the center of the cell, creating: ☐ one parent cell ☐ two parent cells ☐ one daughter cell ☐ two daughter cells	two daughter cells
Mitosis, that is the cell division which passes the same number of chromosomes that were contained in the mother cell to both offspring, is completed in stage: ☐ 1 ☐ 2 ☐ 3 ☐ 4	4
The two daughter cells become physically separate only when: ☐ the chromosomes turn to chromatin ☐ the cell wall pinches together in the middle ☐ the nuclear membranes form ☐ the asters disappear	the cell wall pinches . . .

31.

REFER TO PANEL 2

CHECK the events which occur in the fourth stage of mitosis.

☐ Asters form.	
☐ Asters disappear.	Asters disappear.
☐ Chromosomes appear.	
☐ Chromatin appears.	Chromatin appears.
☐ Chromosomes divide.	
☐ Chromosomes disappear.	Chromosomes disappear.
☐ Chromatin disappears.	
☐ The cell wall pinches in.	The cell wall pinches in.
☐ The daughter cells become separate.	The daughter cells become . . .
☐ Mitosis begins.	
☐ Mitosis is completed.	Mitosis is completed.
☐ Nuclear membranes form.	Nuclear membranes form.
☐ Nuclear membranes disappear.	
☐ Spindle fibers appear.	
☐ Spindle fibers disappear.	Spindle fibers disappear.

32.

DO NOT REFER TO THE PANEL

COMPLETE the table by CHECKING the appropriate boxes:

	Stage				Stage			
	1	2	3	4	1	2	3	4
asters appear	☐	☐	☐	☐	☒	☐	☐	☐
asters disappear	☐	☐	☐	☐	☐	☐	☐	☒
cell wall pinches in	☐	☐	☐	☐	☐	☐	☐	☒
chromosomes appear	☐	☐	☐	☐	☒	☐	☐	☐
chromosomes disappear	☐	☐	☐	☐	☐	☐	☐	☒
chromosomes divide	☐	☐	☐	☐	☒	☐	☐	☐
chromatin appears	☐	☐	☐	☐	☐	☐	☐	☒
chromatin disappears	☐	☐	☐	☐	☒	☐	☐	☐
halves of chromosomes move toward asters	☐	☐	☐	☐	☐	☐	☒	☐
chromosomes arrange themselves in a plane halfway between the asters	☐	☐	☐	☐	☐	☒	☐	☐
the nuclear membrane(s) appear(s)	☐	☐	☐	☐	☐	☐	☐	☒
the nuclear membrane(s) disappear(s)	☐	☐	☐	☐	☒	☐	☐	☐
mitosis begins	☐	☐	☐	☐	☒	☐	☐	☐
mitosis ends	☐	☐	☐	☐	☐	☐	☐	☒
spindle fibers form	☐	☐	☐	☐	☒	☐	☐	☐
spindle fibers disappear	☐	☐	☐	☐	☐	☐	☐	☒

Time completed ____________

YOU HAVE NOW FINISHED THE FIRST PART OF THIS LESSON. WRITE DOWN THE TIME. THEN, AFTER YOU HAVE REVIEWED THE MAIN IDEAS IN THE FOLLOWING SUMMARY, TAKE THE MASTERY TEST AT THE END OF THE BOOKLET.

	DEFINITION
The basic characteristics of an organism are determined by chromosomes.	Chromosomes are formed when the cell is ready to divide from the chromatin material in the nucleus.
Mitosis is a method of cell reproduction in which a mother cell divides thus giving rise to two daughter cells.	The two daughter cells produced by mitosis both have the same kind and number of chromosomes as the mother cell and, thus, the same basic characteristics.
FIRST STAGE OF MITOSIS:	1. Chromatin is organized into distinct forms (the chromosomes). The chromosomes then duplicate themselves. 2. The two centrioles begin to move apart; and while they do so, star-shaped structures called asters form around them and fibers, called spindle fibers, form between them. 3. The nuclear membrane disappears.
SECOND STAGE OF MITOSIS:	Chromosomes line up in a position halfway between the asters and begin to move apart.
THIRD STAGE OF MITOSIS:	Chromosomes move to each aster which are at opposite ends of the cell.
FOURTH (last) STAGE OF MITOSIS:	1. Nuclear membranes reappear around the chromosomes at each end of the cell. 2. The asters and spindle fibers disappear. 3. Chromosomes turn back into the chromatin, the curly threads that fill the nucleus. 4. The cell membranes pinches in toward the center, thus dividing the cytoplasm and creating two complete daughter cells.

MASTERY TEST

Time started ______________

1. Chromosomes are:

   a. ☐ intercellular structures found in animals only

   b. ☐ cellular structures which may be found in the nucleus of any cell in an organism

   c. ☐ cellular structures which may only be found in the nuclei of sex cells

   d. ☐ cellular structures found in the cytoplasm of a cell

2. The basic characteristics of an organism are determined by:

   a. ☐ the number and type of chromosomes in its cells

   b. ☐ the number and type of chromosomes found in intercellular material

   c. ☐ the number and type of vacuoles in its cells

   d. ☐ the weight of the cytoplasmic material in its cells

3. The basic characteristics of an organism produced by asexual reproduction are:

   a. ☐ determined by the basic characteristics of one parent organism

   b. ☐ determined by the basic characteristics of two or more parents

   c. ☐ determined by the basic characteristics of exactly two parents.

   d. ☐ independent of the basic characteristics of the parent organism(s).

4. During the process of mitosis the number of chromosomes in the cell:

a. ☐ remains unchanged

b. ☐ is doubled

c. ☐ is reduced by half

d. ☐ is increased four-fold

5. A. First stage

B. Last stage

LABEL the following events that occur within the process of mitosis with the letter representing the appropriate stage:

1. _____ cell wall pinches in
2. _____ chromosomes appear
3. _____ chromosomes disappear
4. _____ nuclear membrane(s) appear(s)
5. _____ nuclear membrane(s) disappear(s)

Time completed ______________

WHEN YOU HAVE FINISHED THIS TEST, WRITE DOWN THE TIME. THEN TAKE THE LESSON TO YOUR INSTRUCTOR OR HIS ASSISTANT FOR CHECKING. WAIT UNTIL THE LESSON IS APPROVED BEFORE GOING ON TO THE NEXT LESSON.

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ADVANCED
GENERAL EDUCATION PROGRAM

A HIGH SCHOOL SELF-STUDY PROGRAM

REPRODUCTION BY MALE AND FEMALE CELLS

LEVEL: III
UNIT: 3
LESSON: 6

U.S. DEPARTMENT OF LABOR
MANPOWER ADMINISTRATION, JOB CORPS
NOVEMBER 1969

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MANPOWER ADMINISTRATION, JOB CORPS
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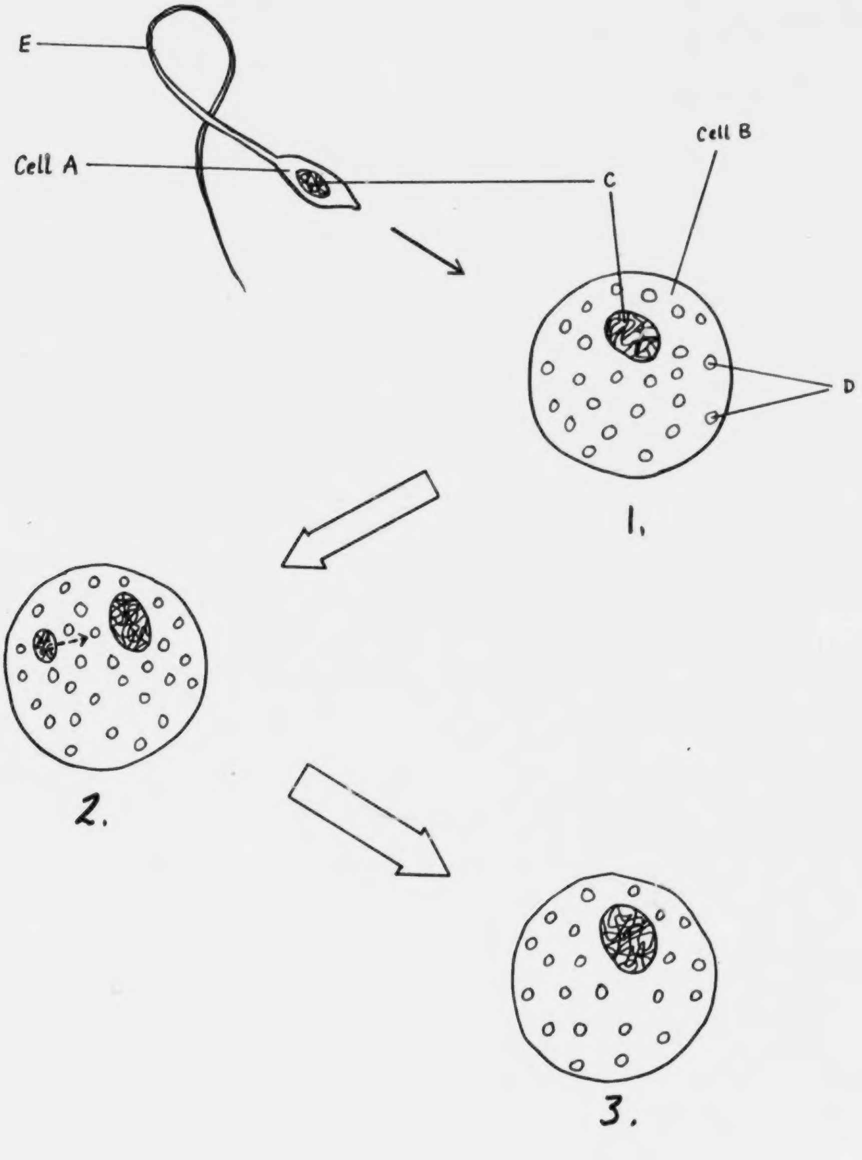
1.	
PREVIEW FRAME	
Mitotic division, or mitosis, is a process of cellular reproduction in which a single mother cell divides into two daughter cells. Each daughter cell has the same basic characteristics as the original mother cell.	
In the next section you will learn about another type of reproduction, in which two different cells join and produce a new organism whose basic characteristics are determined by the characteristics of both parent cells.	
NO RESPONSE REQUIRED	GO ON TO THE NEXT FRAME
2.	
A cell undergoes mitotic division. The daughter cell is derived from:	
☐ one mother cell ☐ two parent cells	one mother cell
A mare and a stallion mate. The mare eventually gives birth to a foal. The foal is an offspring of:	
☐ one parent ☐ two parents	two parents
Both of the above are examples of the life function called:	
☐ respiration ☐ reproduction	reproduction

3. The process by which two parents produce offspring is called sexual reproduction. If only one parent organism is needed to produce offspring, the process is called asexual reproduction. MATCH the following: A. asexual reproduction B. sexual reproduction 1. ______ A bacterium divides mitotically into two bacteria. 2. ______ A woman gives birth to a child.	1. A 2. B
4. Mitosis is an example of: ☐ asexual reproduction ☐ sexual reproduction The case in which two parents take part in producing the offspring is called: ☐ asexual reproduction ☐ sexual reproduction	asexual reproduction sexual reproduction
5. PREVIEW FRAME This lesson discusses the Reproductive System of the human organism. You will learn in detail about the process by which children are produced. In the next section you will learn about the general features of sexual reproduction in complex multicellular organisms. NO RESPONSE REQUIRED	GO ON TO THE NEXT FRAME

PANEL 1


E
Cell A
Cell B
C
D
1.
2.
3.

6. REFER TO PANEL 1 In sexual reproduction, the parents are of two distinct types, or sexes: male and female. Each parent contributes a special cell for the process of reproduction. The male parent contributes a cell which is tiny and moves toward the female cell; the female parent contributes a relatively large and stationary cell. In the panel, the male cell is cell: ☐ A ☐ B	A
The female cell is cell: ☐ A ☐ B	B
You can guess that structures C are the: ☐ centrioles ☐ chromosomes ☐ nuclei	nuclei
7. REFER TO PANEL 1 According to the illustrations, the male cell in sexual reproduction is: ☐ larger than the female cell ☐ smaller than the female cell	smaller than the female cell
The male cell: ☐ moves toward the female cell ☐ moves away from the female cell ☐ does not move	moves toward the female cell

8.	
REFER TO PANEL 1	
The cells contributed by the parents in sexual reproduction are called sex cells, or gametes.* The male gamete is called a sperm.** The female sex cell is called an ovum.***	
The ovum in Panel 1 is cell:	
☐ A	
☐ B	B
Which of the following is(are) gametes ?	
☐ cell A	cell A
☐ cell B	cell B
☐ structure C	
Which sex cell(s) contain(s) a nucleus ?	
☐ the sperm	the sperm
☐ the ovum	the ovum
Which sex cell appears to have a tail ?	
☐ the sperm	the sperm
☐ the ovum	
The ovum comes from:	
☐ the male parent	
☐ the female parent	the female parent

*Gamete (ga-met) from the Greek word for marriage.

**Sperm, Latin for seed.

***Ovum, Latin for egg.

9.	
REFER TO PANEL 1	
The tail on the sperm helps it to move. It is called the flagellum.*	
The structures marked D are particles of food in the cytoplasm of the ovum. They are called yolk.	
Yolk is found in the:	
☐ male gamete	
☐ female gamete	female gamete
A flagellum is found on the:	
☐ male gamete	male gamete
☐ female gamete	
MATCH the following by writing one letter in each blank:	
A. flagellum 1. _____ provides movement	1. A
B. yolk 2. _____ provides nourishment	2. B
*Flagellum (flag-el-lum), Latin for whip to describe the whip-like motion of the moving tail.	

10.	
REFER TO PANEL 1	
In Step 2, the: ☐ ovum has entered the sperm ☐ sperm has entered the ovum	sperm has entered the ovum
In Step 3, the nuclei unite and a single cell is formed, called the zygote.* This union of male and female gametes is called fertilization.	
A zygote is formed from: ☐ only an ovum ☐ only a sperm ☐ an ovum and a sperm ☐ none of the above	an ovum and a sperm
In fertilization: ☐ one parent cell is involved ☐ two parent cells are involved	two parent cells are involved
*Zygote (sigh-got) is Greek for joined.	
11.	
REFER TO PANEL 1	
A sperm and an ovum unite to form a: ☐ gamete ☐ flagellum ☐ zygote	zygote
This is the process called: ☐ fertilization ☐ mitosis	fertilization

12.

DO NOT REFER TO THE PANEL

MATCH the terms to their descriptions by writing one letter in each blank:

A. fertilization

B. flagellum

C. gamete

D. ovum

E. sperm

F. yolk

G. zygote

1.	_____	food within cytoplasm of ovum	1. F
2.	_____	helps sperm to move	2. B
3.	_____	sex cell of either sex	3. C
4.	_____	female sex cell	4. D
5.	_____	male sex cell	5. E
6.	_____	cell formed by union of ovum and sperm	6. G
7.	_____	union of ovum and sperm	7. A
8.	_____	larger of the two sex cells	8. D
9.	_____	sex cell which swims	9. E
10.	_____	example of sexual reproduction	10. A

13.	
In sexual reproduction, a sex cell from one parent unites with a sex cell from another parent in the process of:	
☐ fertilization ☐ mitosis	fertilization
The cell which results from the union of the two sex cells is called a zygote.	
This cell gets one-half of its number of chromosomes from one sex cell and the other half from the other sex cell.	
The zygote formed from the union of two human sex cells has 46 chromosomes.	
Each of the gametes has:	
☐ 23 chromosomes ☐ 46 chromosomes ☐ 92 chromosomes	23 chromosomes
14.	
The gametes, or sex cells, of organisms which reproduce sexually, are different from the other cells in the organism.	
Each gamete has:	
☐ half as many chromosomes as other cells in the organism	half as many chromosomes . . .
☐ the same number of chromosomes as other cells in the organism	
☐ twice as many chromosomes as other cells in the organism	
Two gametes (ovum and sperm) unite to form a zygote, which has:	
☐ half as many chromosomes as each of the gametes	
☐ the same number of chromosomes as each of the gametes	
☐ twice as many chromosomes as each of the gametes	twice as many chromosomes . . .

15.	
All of the cells in the new multicellular organism which develops from the zygote (except the sex cells) have the same number of chromosomes that were present in the zygote. You would assume, therefore, that the organism is a result of:	
☐ mitotic division ☐ fertilization	mitotic division fertilization
The gametes of an organism have only half the number of chromosomes normally found in other cells of the organism. The gamete is the result of a process called meiosis*, or meiotic division.	
Which of the following are formed as a result of meiotic division?	
☐ all cells which develop from the zygote ☐ female gamete ☐ male gamete ☐ ovum ☐ sperm	female gamete male gamete ovum sperm
*Meiosis (my-o-sis) means lessening, that is, each resulting cell is less than the mother cell.	

16.	
A human gamete (male or female) has 23 chromosomes.	
A human zygote has: ☐ 23 chromosomes ☐ 46 chromosomes ☐ 92 chromosomes	46 chromosomes
The cells which further develop from the human zygote by mitotic division each have: ☐ 23 chromosomes ☐ 46 chromosomes ☐ 92 chromosomes	46 chromosomes
In the zygote: ☐ half of the chromosomes come from the male parent and half come from the female parent ☐ all the chromosomes come from the male gamete ☐ all the chromosomes come from the ovum	half of the chromosomes . . .

17.	
Nearly all of the cells in an organism which develops from a zygote are formed as a result of mitotic division.	
The sex cells, or gametes, however, are formed as a result of: ☐ fertilization ☐ meiosis ☐ the union of sperm and ovum	meiosis
In most human cells there are 46 chromosomes.	
In human gametes, there are: ☐ 23 chromosomes ☐ 46 chromosomes ☐ 92 chromosomes	23 chromosomes
This is an example of the general rule that gametes pass: ☐ half as many chromosomes as the other cells in the organism ☐ the same number of chromosomes as the other cells in the organism ☐ twice as many chromosomes as the other cells in the organism	half as many chromosomes . . .

18. Cell A results from the meiotic division of its mother cell. Cell B results from the mitotic division of its mother cell.	
Which cell is a gamete? ☐ A ☐ B ☐ neither	A
Which cell has the same number of chromosomes as its mother cell? ☐ A ☐ B ☐ neither	B
Which cell has half the number of chromosomes as were present in the mother cell? ☐ A ☐ B ☐ neither	A

19.	
Meiosis and mitosis are similar because they are both:	
☐ processes in which a sperm unites with an ovum	
☐ processes of cellular reproduction	. . . of cellular reproduction
☐ types of cell division	types of cell division
☐ types of fertilization	
20.	
Gametes are formed from special cells by a process of meiosis. The cells from which gametes are formed have:	
☐ half as many chromosomes as the gametes	
☐ the same number of chromosomes as the gametes	
☐ twice as many chromosomes as the gametes	twice as many chromosomes . . .
A gamete which has gone through meiotic division has:	
☐ half as many chromosomes as the cell from which it was formed	half as many chromosomes . . .
☐ the same number of chromosomes as the cell from which it was formed	
☐ twice as many chromosomes as the cell from which it was formed	

21.

A. fertilization

B. gametes

C. meiosis

D. mitosis

E. ovum

F. sperm

G. zygote

MATCH the terms above with the appropriate statements below. (A term may be used more than once.)

1. _____ cell division in which the resulting daughter cells have half as many chromosomes as the mother cell	1. C
2. _____ cell division in which the resulting daughter cells have the same number of chromosomes as the mother cell	2. D
3. _____ cell(s) formed by meiotic division	3. B, E, F
4. _____ cell from which an organism develops by successive mitotic divisions	4. G
5. _____ cell resulting from union of gametes	5. G
6. _____ process in which sperm unites with ovum	6. A
7. _____ sex cell(s)	7. B, E, F

22.	
You have already learned that a cell which results from mitotic division has the same basic characteristics as the cell from which it developed.	
This is due to the fact that the set of chromosomes in each daughter cell:	
☐ exactly resembles the set, in number and type, which was present in the mother cell	exactly resembles the set, . . .
☐ has half the number of chromosomes originally present in the mother cell	
Mitotic division is a type of:	
☐ asexual reproduction ☐ sexual reproduction	asexual reproduction
23.	
Some organisms, such as bacteria and other uncellular animals, reproduce asexually. In such cases, each offspring is formed as a result of:	
☐ the meiotic division of one parent organism	
☐ the successive mitotic division of the zygote formed from the sex cells of two parents	
☐ the mitotic division of one parent organism	the mitotic division of one . . .
Most organisms, including humans, reproduce sexually. In such cases, each offspring is formed as a result of:	
☐ successive mitotic division of the zygote formed from the sex cells of two parents	successive mitotic . . .
☐ the meiotic division of one parent organism	
☐ the mitotic division of one parent organism	

24.	
The basic characteristics of an organism which results from asexual reproduction:	
☐ are determined by the set of chromosomes in one parent organism	. . . in one parent organism
☐ are determined by the sets of chromosomes in two parent organisms	
☐ are independent of the chromosomes in parent organism(s)	
The basic characteristics of an organism which results from sexual reproduction:	
☐ are determined by the set of chromosomes in one parent organism	
☐ are determined by the sets of chromosomes in two parent organisms	. . . in two parent organisms
☐ are independent of the chromosomes of the parent organism(s)	
25.	
A. asexual reproduction	
B. sexual reproduction	
MATCH the terms above with the statements below:	
1. _____ basic characteristics of an offspring determined by chromosomes from one parent organism	1. A
2. _____ chromosomes from two parents determine the characteristics of the offspring	2. B
3. _____ organism reproduced by mitotic division of one parent	3. A
4. _____ two gametes unite to form a zygote	4. B

26.	
The basic characteristics of an organism which develops from a zygote are determined by:	
☐ the chromosomes of the male sex cell only	
☐ the chromosomes of the female sex cell only	
☐ the total set of chromosomes of the male and female gametes	the total set of . . .
Organisms which reproduce sexually produce offspring whose basic characteristics are:	
☐ determined by the basic characteristics of the two parents	determined by the basic . . .
☐ unrelated to the basic characteristics of only one of the parents	
☐ determined by the characteristics of the male parent only	
27.	
In sexual reproduction each of the two parents determines the basic characteristics of the offspring. This occurs as a result of:	
☐ the combining of the two gametes to form a zygote	the combining of the two . . .
☐ the formation of the zygote from one gamete only	
☐ the process of fertilization	the process of fertilization
☐ the mitotic division of the zygote	

28.

The basis of sexual reproduction is the union of two gametes to form a zygote.

Each of the gametes:

- ☐ contributes chromosomes from each of the parents
- ☐ contributes chromosomes from only one of the parents
- ☐ has as many chromosomes as are found in other cells of the organism
- ☐ has half as many chromosomes as are found in other cells of the organism

contributes chromosomes . . .

has half as many . . .

29.

In sexual reproduction, the transfer of characteristics from parents to offspring depends on:

- ☐ mitotic division of the zygote
- ☐ fertilization of the ovum by the sperm
- ☐ union of two gametes

fertilization of the ovum . . .
union of two gametes

Time completed ________________

YOU HAVE NOW FINISHED THE FIRST PART OF THIS LESSON. WRITE DOWN THE TIME. THEN, AFTER YOU HAVE REVIEWED THE MAIN IDEAS IN THE FOLLOWING SUMMARY, TAKE THE MASTERY TEST AT THE END OF THE BOOKLET.

SEXUAL REPRODUCTION: Example - human reproduction	Two parents give use to a new organism with the same basic characteristics.
ASEXUAL REPRODUCTION: Example - cellular mitosis	One parent give use to a new organism with the same basic characteristics.
SEXUAL REPRODUCTION involves a male gamete (sperm) and a female gamete (ovum).	The sperm is relatively smaller than the ovum. And the sperm is equipped with a flagellum which enables it to move, whereas the ovum is stationary. The ovum, however, contains particles of food, called yolk, which are not found in sperm.
FERTILIZATION - process whereby the nuclei of a sperm and an ovum white thus forming a zygote.	Zygote is the cell which results from the union of two gametes. The zygote gets one-half of its number of chromosomes from the male parent and the other half from the female parent. Thus, the basic characteristics of the zygote are determined by both parents. EXAMPLE: the human zygote contains 46 chromosomes. Human sperm contain 23 chromosomes. Human ova contain 23 chromosomes.
MEIOSIS - process of cellular reproduction in which the daughter cells produced have half the number of chromosomes that the other cells of the organism have.	The gametes, the cells with half the number of chromosomes, are produced by meiotic division.
After fertilization the zygote develops by a series of mitotic divisions.	

MASTERY TEST

Time started ______________

NOTE NOTE NOTE NOTE NOTE

Skip one(1) page to find page 22.

1.

A. meiosis

B. mitosis

MATCH the terms above with the appropriate descriptions below. In some case(s) both terms may be matched with one description.

1. _____ basis of asexual reproduction

2. _____ daughter cell has half the number of chromosomes as the original cell

3. _____ formation of sex cells

4. _____ number of chromosomes in a daughter cell is the same as the number in the mother cell

5. _____ process by which nearly all cells in an organism reproduce

6. _____ process of cell division

NOTE: Continue with question 2 on the next page.

2. MATCH the terms to the statements by writing one or more letters in each blank.

A. fertilization

B. gamete

C. ovum

D. sperm

E. zygote

1. _____ formation of a zygote
2. _____ cell formed from union of gametes
3. _____ cell from which organism develops by successive mitotic division
4. _____ cell with half the number of chromosomes that are found in all other cells of the organism
5. _____ female sex cell
6. _____ larger of the two sex cells
7. _____ male sex cell
8. _____ process whereby sperm penetrates and unites with ovum

Time completed ______________

WHEN YOU HAVE FINISHED THIS TEST, WRITE DOWN THE TIME. THEN TAKE THE LESSON TO YOUR INSTRUCTOR OR HIS ASSISTANT FOR CHECKING. WAIT UNTIL THE LESSON IS APPROVED BEFORE GOING ON TO THE NEXT LESSON.

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ADVANCED
GENERAL EDUCATION PROGRAM

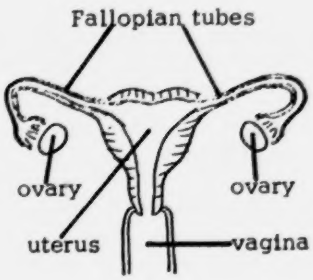
A HIGH SCHOOL SELF-STUDY PROGRAM

THE HUMAN REPRODUCTIVE SYSTEM
LEVEL: III
UNIT: 3
LESSON: 7

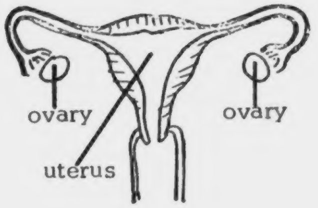
U.S. DEPARTMENT OF LABOR
MANPOWER ADMINISTRATION, JOB CORPS
NOVEMBER 1969

214

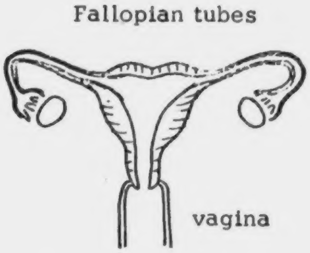
U.S. DEPARTMENT OF LABOR
MANPOWER ADMINISTRATION, JOB CORPS
NOVEMBER 1969

1. This program is designed to teach you the basic parts and functions of the human reproductive system, both male and female. Part I will deal with the female system and Part II with the male system. Diagrams will be used throughout to illustrate the material discussed. NO RESPONSE REQUIRED	GO ON TO THE NEXT FRAME
2. The main parts of the female reproductive system are shown below.  The ovary on each side is connected to the uterus by the ________________. The uterus is connected with the outside of the body by the ________________.	Fallopian tubes vagina

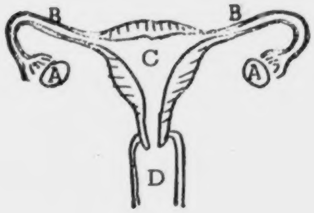
3.


ovary
ovary
uterus

The ovaries are connected to the uterus by the:	
☐ Fallopian tubes	Fallopian tubes
☐ vagina	
This structure is found:	
☐ in the middle	
☐ on both sides	on both sides
☐ on one side only	

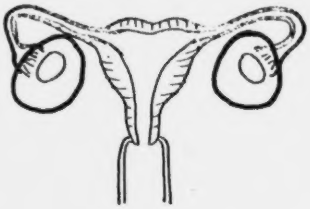
4.  	
The structure which connects the uterus with the outside of the body is the ______________.	vagina
Which of the following structures are found in duplicate in the female reproductive system: ☐ Fallopian tube ☐ ovary ☐ uterus ☐ vagina	Fallopian tube ovary

5.



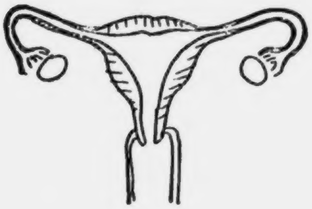
MATCH each letter from the drawing with the name of the corresponding structure:

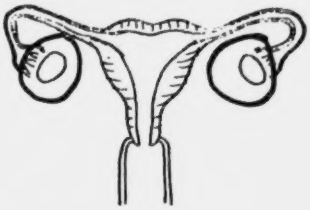
_____ ovary	A
_____ uterus	C
_____ vagina	D
_____ Fallopian tube	B

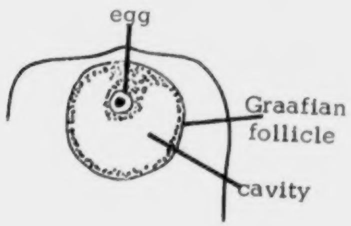
6. The female reproductive cell (or gamete), also called the ovum or "egg," is produced in the part of the female reproductive system circled below.  The ovum is produced in the: ☐ Fallopian tube ☐ ovary ☐ uterus ☐ vagina	ovary
7. What part of the female reproductive system produces the egg? ________________ The structure is found: ☐ in the middle of the body ☐ on both sides of the body ☐ on one side of the body only	the ovary on both sides of the body

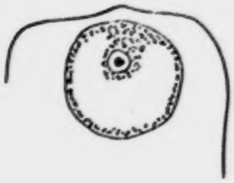
8.

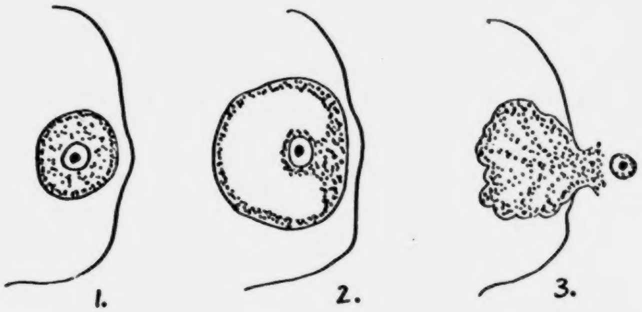
CIRCLE the part or parts of the female reproductive system where the gametes are produced.

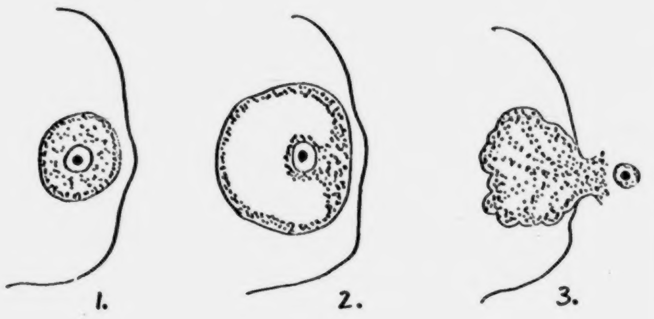




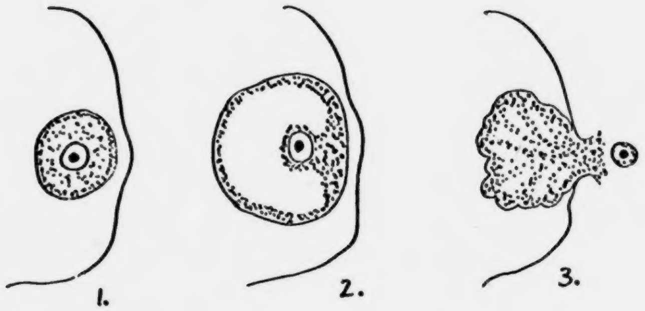
9.  The drawing above shows the structure inside the ovary in which an ovum develops.	
The structure inside the ovary in which the egg develops is called a ________________.	Graafian follicle
Within this structure is found the egg and a ___________.	cavity
How many eggs are in the follicle? ☐ one ☐ two ☐ three ☐ four or more	one
10. Many Graafian follicles are found in each human ovary; usually, each follicle contains one developing egg. Which of the following statements is true? ☐ Only one Graafian follicle is present in each ovary. ☐ Many Graafian follicles are present in each ovary - each follicle contains one egg. ☐ Many Graafian follicles are present in each ovary - each follicle contains several eggs.	Many Graafian follicles are . . . .

11.	
	
The structure shown above is a:	
☐ Fallopian tube	
☐ Graafian follicle	Graafian follicle
☐ ovary	
☐ uterus	
☐ vagina	
12.	
Within an ovary there:	
☐ are many Graafian follicles	are many Graafian follicles
☐ is one Graafian follicle	
A Graafian follicle contains:	
☐ one egg	one egg
☐ many eggs	
How many ovaries does a human female have? _____	2 (two)

13.  The illustration above shows an egg developing in a Graafian follicle. In the third drawing, the egg is going through the process of ovulation. In ovulation the egg is: ☐ held within the Graafian follicle ☐ expelled from the Graafian follicle	expelled from the Graafian follicle
14. During ovulation which of the following happen(s)? ☐ The egg moves into the Graafian follicle. ☐ The egg is closed. ☐ The Graafian follicle ruptures. ☐ The ripe egg is liberated from the Graafian follicle.	The Graafian follicle ruptures. The ripe egg is liberated . . . .
Ovulation occurs: ☐ when the egg is developed ☐ before the egg develops	when the egg is developed

15. 	
The diagrams above show the 3 important stages of the development of the egg within the Graafian follicle.	
As the egg develops, the cavity within the Graafian follicle: ☐ increases ☐ decreases	increases
After the second drawing the Graafian follicle is ready to rupture and expell the developed egg. This process is called ________________.	ovulation

16.



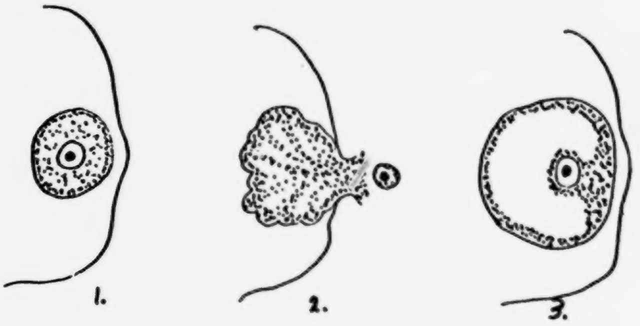
In drawing 1, the egg:

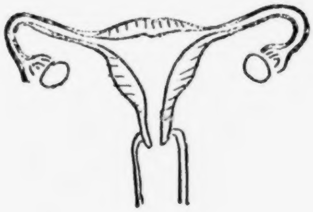
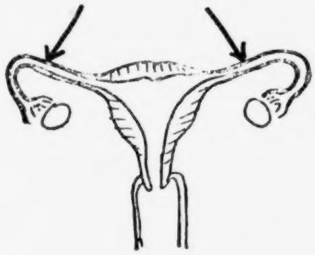
☐ is developed
☐ is not developed

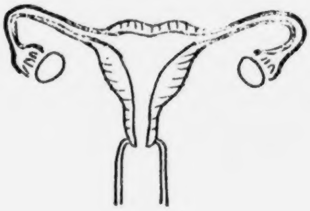
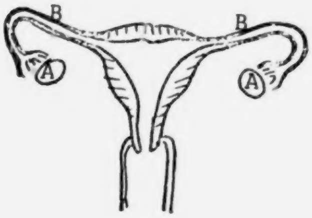
Which drawing illustrates ovulation? ______________

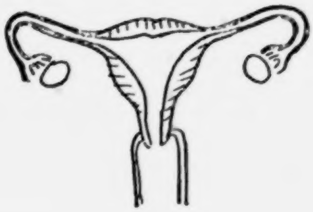
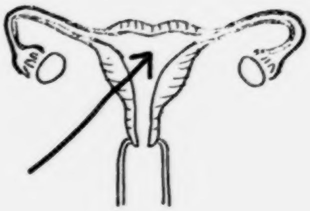
is not developed

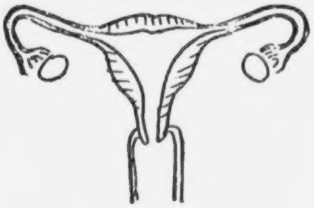
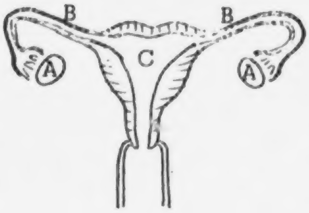
Diagram 3

17. 	
A Graafian follicle that is ready to break is shown in Diagram _____.	3
Soon the Graafian follicle will rupture. What will happen to the egg? ______________________________	It will be expelled or released.
This process is called _______________.	ovulation
18. The female reproductive cell, or egg, is produced in the: ☐ Fallopian tube ☐ ovary ☐ uterus ☐ vagina	ovary
What happens to the Graafian follicle during ovulation? ______________________________	It ruptures and the egg is expelled. (or equivalent response)

19. Once the mature egg has been expelled from the ovary it enters the part of the female reproductive system which connects the ovary with the uterus. This part is the: ☐ Fallopian tube ☐ ovary ☐ uterus ☐ vagina	Fallopian tube
20. After ovulation, the egg enters one of the Fallopian tubes. It is here that the egg is usually fertilized by a male cell, or sperm. DRAW two arrows to show where fertilization usually takes place. 	

21. To review what you have learned thus far, LABEL the part(s) of the diagram where eggs are produced "A." LABEL the part(s) of the diagram where fertilization may occur "B." 	
22. In the human female ovulation occurs approximately once each month. At ovulation, usually only one egg is released -- the egg may come from either the left ovary or the right ovary. How many Graafian follicles usually rupture every month? _____ About how many eggs does a human female ovulate per year? _____	one 12
23. In the human female about 12 eggs are released: ☐ each month ☐ each week ☐ each year	each year

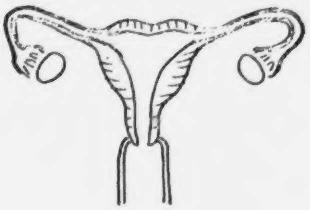
24. After ovulation, the egg may or may not be fertilized. As soon as the egg is fertilized, pregnancy begins. About 8 or 9 days after fertilization occurs, the egg will pass into the uterus where it embeds or attaches itself to the lining or endometrium (en-do-me-tri-um).  DRAW an arrow to the part of the female reproductive system where the fertilized egg becomes embedded after the eighth or ninth day of pregnancy. Endometrium is a word for the lining of the ___________.	 uterus
25. During: ☐ ovulation ☐ pregnancy the fertilized egg is embedded in the endometrium. The endometrium is the lining of the: ☐ Fallopian tube ☐ ovary ☐ uterus ☐ vagina	pregnancy uterus

26. LABEL A the part(s) of the diagram showing where eggs are produced. LABEL B the part(s) of the diagram showing where the travels after ovulation. LABEL C the part(s) of the diagram showing where the egg becomes embedded after the eighth or ninth day of pregnancy. 	
27. If fertilization does not occur the unfertilized egg passes out of the body about two weeks after ovulation, during the process of menstruation (bleeding).*	
About how many times a year does the human female ovulate? _____________	12 times
Assuming that fertilization does not occur, about how many times a year will menstruation occur? _____	12 times
*The old Roman Calendar went by moon (mens) cycles of 28 days. Menstruation is from Latin for, happens monthly.	

28. Menstruation occurs about two weeks after ovulation only if fertilization does not occur. If fertilization does occur menstruation will not resume until after the birth of the baby. The absence of menstruation may be a sign that: ☐ a woman is pregnant ☐ a woman is not pregnant	a woman is pregnant
29. The duration of pregnancy in humans is about 9 months from conception to birth. The fertilized egg develops in the part of the reproductive system in which it is embedded after fertilization. That part is the: ☐ Fallopian tube ☐ ovary ☐ uterus ☐ vagina In humans, pregnancy lasts about: ☐ 1/2 year ☐ 3/4 year ☐ 1 year Menstruation: ☐ is absent during pregnancy ☐ occurs during pregnancy	uterus 3/4 year is absent during pregnancy

30.

DRAW an arrow to the structure in which a baby develops.

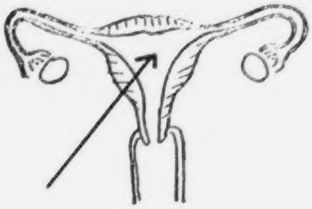


The process of pregnancy lasts for about:

- ☐ 6 months
- ☐ 9 months
- ☐ 12 months

You have seen how a womans' belly swells in pregnancy. Her or any animal's unborn child is called an embryo, which is Greek for swelling.

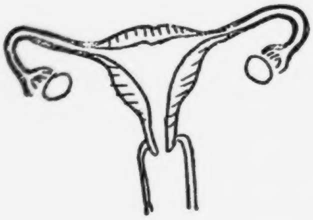
After eight weeks the embryo is still very small but has developed its bone structure and organs. It is then called a fetus, which is Latin for fruitful.



9 months

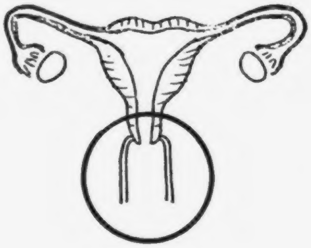
31.

When the baby is developed and ready for birth, the uterus contracts forcefully and the baby is "born" by passing out of the body from the uterus through the structured circled below.



This structure is the:

- ☐ endometrium
- ☐ Fallopian tube
- ☐ Graafian follicle
- ☐ ovary
- ☐ vagina



vagina

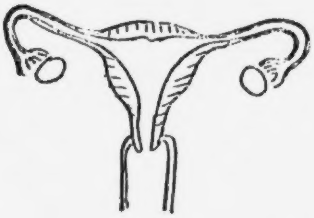
32.

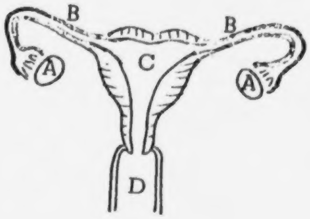
In the diagram below LABEL A the structure(s) where the egg develops.

LABEL B the structure(s) where fertilization may occur.

LABEL C the structure(s) where the baby develops during pregnancy.

LABEL D the structure(s) through which the baby passes at birth.





33.

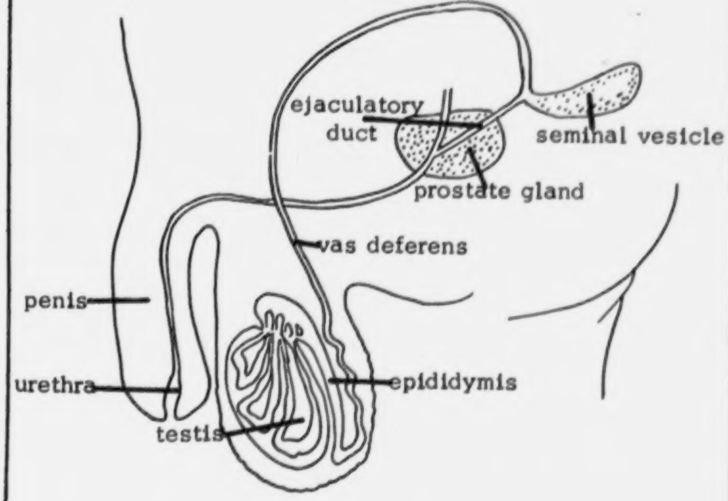
PREVIEW FRAME

We will now discuss the reproductive system in the male.

NO RESPONSE REQUIRED

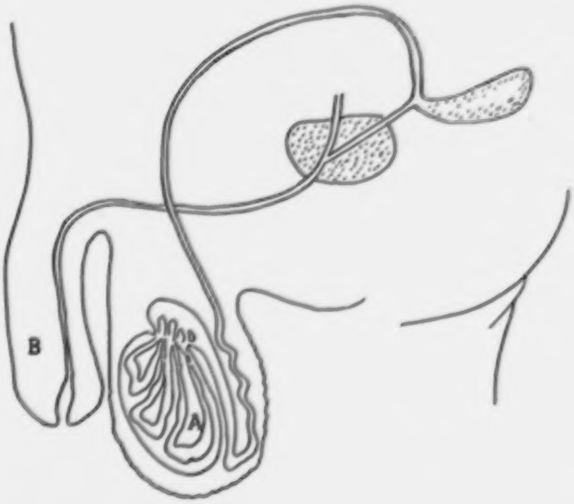
GO ON TO THE NEXT FRAME

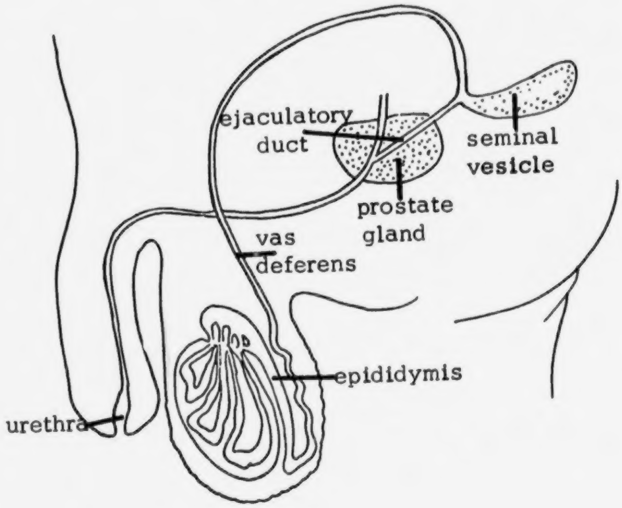
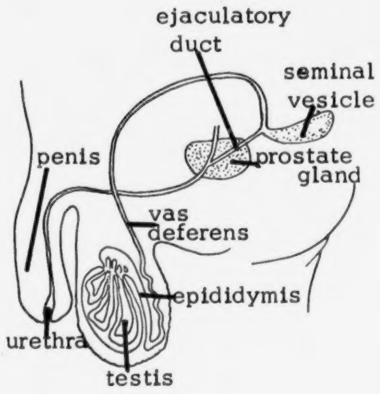
34.


ejaculatory duct
seminal vesicle
prostate gland
vas deferens
penis
urethra
epididymis
testis

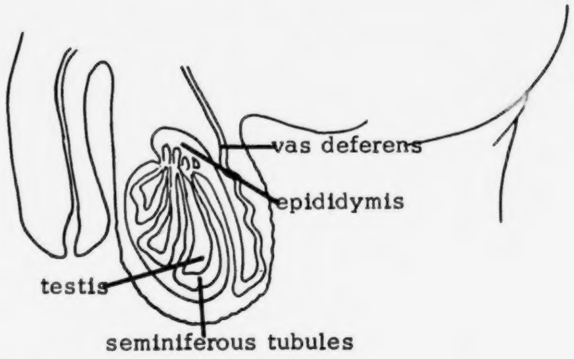
The male reproductive system has two major parts: the penis and the two testes. There are also tubes connecting the penis with each of the testes and other structures which are part of the system.

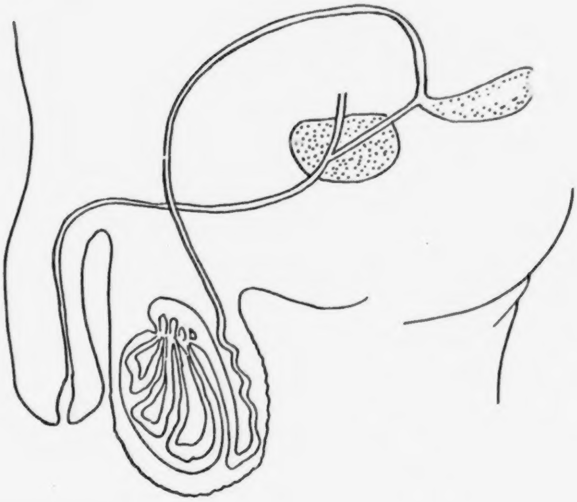
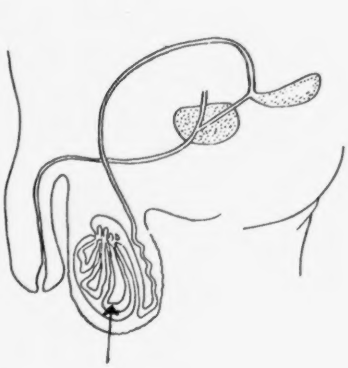
Which four structures are connecting tubes?	
____________	epididymis
____________	vas deferens
____________	ejaculatory duct
____________	urethra
Besides these tubes and the penis and testes, what other structures are shown?	
____________	seminal vesicle
____________	prostate

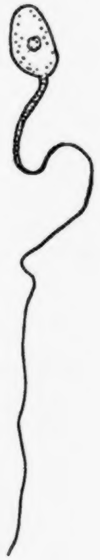
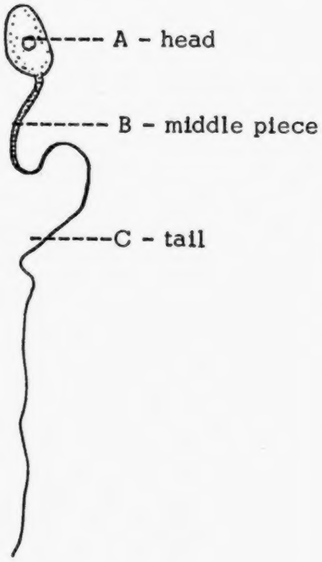
35. 	
The testes occur in pairs in the normal human male. Each of the two glands is called a testis. The testes are labeled _____ above.	A
The other main part of the male reproductive system, labeled B, is the: ☐ epididymis ☐ penis ☐ prostate gland ☐ seminal vesicle ☐ urethra ☐ vas deferens	penis

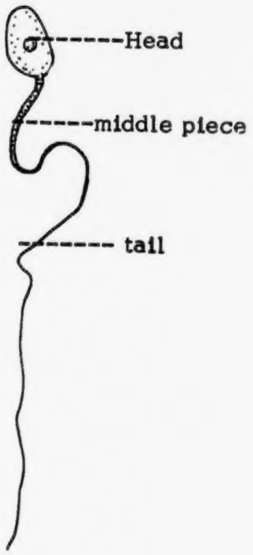
36.	
LABEL the penis and the testes in the diagram above.	
 ejaculatory duct seminal vesicle prostate gland vas deferens epididymis urethra	 ejaculatory duct seminal vesicle penis prostate gland vas deferens epididymis urethra testis
How many testes does a human male normally have? _____	two
Which of the following are connecting tubes?	
☐ ejaculatory duct	ejaculatory duct
☐ epididymis	epididymis
☐ prostate gland	
☐ seminal vesicle	
☐ urethra	urethra
☐ vas deferens	vas deferens

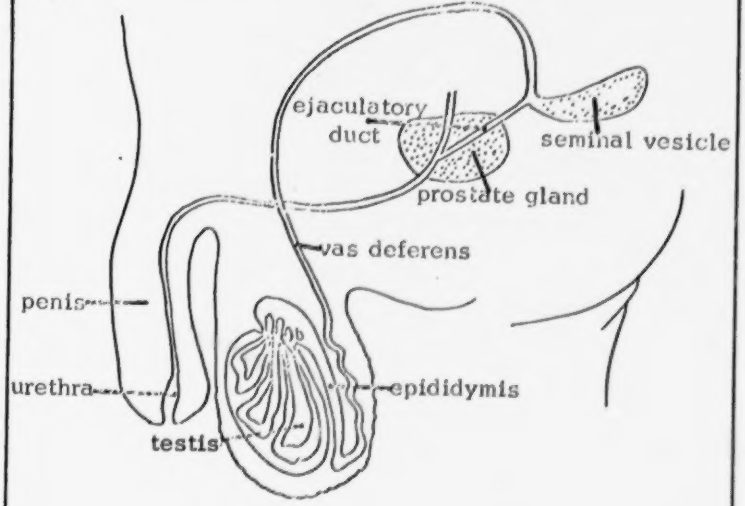
37.	
The testes are the parts of the male reproductive system in which the male sex cells or sperm are produced.	
How many testes does a man usually have? _____	2 (two)
What structure in the female does the comparable job of producing sex cells? _______________	ovary

38.  vas deferens epididymis testis seminiferous tubules The epididymis and the vas deferens are tubes which connect each of the testes with the penis. Sperm is not produced in either of these tubes. You would guess that the part(s) of the testes in which sperm are produced must therefore be the _______________.	seminiferous tubules
39. The process of sperm production is called spermatogenesis. Spermatogenesis occurs in the: ☐ testes ☐ penis	testes
Within this structure the particular part(s) where spermatogenesis occur(s) is/are: ☐ epididymis ☐ seminiferous tubules ☐ vas deferens	seminiferous tubules

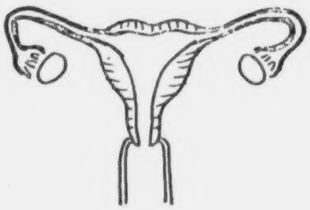
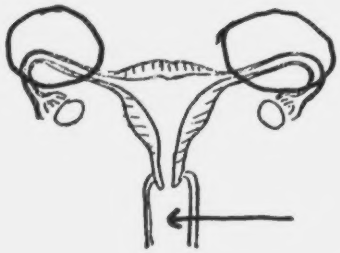
40. Spermatogenesis is the process in which sperm are: ☐ produced in the testes ☐ released from the penis	produced in the testes
41. DRAW an arrow to show the part of the testis where sperm are produced. 	
The arrow indicates the: ☐ epididymis ☐ seminiferous tubules ☐ vas deferens	seminiferous tubules
The process of sperm production is called ___________ atogenesis.	sperm

42. In what major part of the male reproductive system are sperm formed? ______________ What is the process by which sperm are produced called? ______________	testes spermatogenesis
43. The illustration below shows a greatly enlarged version of a human male sperm. The sperm has three parts: the head, the middle piece, and the tail. In the diagram, LABEL these parts A, B and C respectively. 	

44.  The structure shown above is a _______________. This structure is produced in the _______________.	sperm (cell) testis (testes)
45. In the process of ejaculation, millions of sperm pass from the penis from which they may be deposited in the female vagina. ☐ Ejaculation resembles ovulation in that only one sperm is released at a time. ☐ Ejaculation differs from ovulation in that millions of sperm are released at a time.	Ejaculation differs from . . . .

46.  ejaculatory duct seminal vesicle prostate gland vas deferens penis urethra epididymis testis In order for the sperm to pass from the seminiferous tubules of the testis to the penis and from there into the vagina, the sperm must pass through 4 tubes. LIST these 4 tubes in the order in which the sperm pass through them. _______________ _______________ _______________ _______________	epididymus vas deferens ejaculatory duct urethra
47. In ejaculation: ☐ one sperm is released ☐ millions of sperms are released	millions of sperms are released

48. CHECK the parts of the male reproductive system. ☐ ejaculatory duct ☐ epididymis ☐ penis ☐ prostate ☐ seminal vesicle ☐ testes ☐ urethra ☐ vas deferens ☐ uterus ☐ vagina ☐ ovary ☐ Fallopian tube	ejaculatory duct epididymis penis prostate seminal vesicle testes urethra vas deferens
49. The function of the prostate gland and some of the tubes of the male reproductive system is to add fluid to the sperm. The sperm plus the fluid is called semen. Semen leaves the body from the: ☐ ejaculatory duct ☐ epididymis ☐ penis ☐ prostate gland ☐ seminal vesicle ☐ urethra ☐ vas deferens	penis
50. Sperm plus fluid is called: ☐ semen ☐ sperm	semen

51. Semen is composed of sperm from the testes and fluids supplied by the connecting tubes and the prostate gland. On ejaculation, semen is released from the penis and may be deposited in the female vagina. If this occurs, the vagina will contain: ☐ one sperm ☐ several sperms ☐ millions of sperms	millions of sperms
52. DRAW an arrow to show where sperm are deposited within the female reproductive system. CIRCLE the area or areas where fertilization usually takes place. 	

53.	
The long tail which sperms have enable them to "swim" in a fluid environment.	
How do sperms get from the vagina to the Fallopian tubes? ________________	they swim
54.	
Only one sperm is needed to fertilize an egg. How many sperms are deposited in the vagina after ejaculation? ☐ one ☐ several ☐ millions	millions
How many sperms must penetrate the egg for pregnancy to result? _____	one
55.	
You have already learned that fertilization usually takes place in the Fallopian tubes. How many sperm are needed to fertilize the egg? _____	one
How do sperms travel from the vagina to the Fallopian tubes? ________________	they swim
	Time completed ________________

YOU HAVE NOW FINISHED THE FIRST PART OF THIS LESSON. WRITE DOWN THE TIME. THEN, AFTER YOU HAVE REVIEWED THE MAIN IDEAS IN THE FOLLOWING SUMMARY, TAKE THE MASTERY TEST AT THE END OF THE BOOKLET.

OVARIES	There are two ovaries, one on the left and one on the right side of the body. The ovaries contain the Graafian follicles. Each ovum (female gamete) develops in a Graafian follicle in the ovary. About twelve times a year an egg is ovulated that is, a Graafian follicle ruptures thus releasing an egg.
The FALLOPIAN TUBES	connect each of the ovaries with the uterus. Fertilization usually takes place in the Fallopian tubes.
If the ova is fertilized:	
PREGNANCY begins	The fertilized ovum begins developing immediately. It moves through the Fallopian tube to the uterus where it embeds itself in the endometrium, the lining of the uterus.
UTERUS	is the organ where the fetus, the growing embryo, develops. A fetus usually takes about 9 months to develop. At the termination of pregnancy, the fetus passes through the vagina.
VAGINA	The organ leading from the uterus to the outside of the body. The fetus passes through the vagina when it is born. This organ also receives sperm from the male.
If the ova is not fertilized:	
the unfertilized egg is passed from the body, along with the endomelium, through the vagina. This occurs about ten days after ovulation and is known as menstruation.	Since ovulation occurs about twelve times a year, menstruation also occurs about twelve times a year. However, if the ova is fertilized, menstruation and the next ovulation cease until the pregnancy is terminated.

TESTES (singular testis) are the two parts of the male reproductive system in which the male gametes, the sperms are produced. The process by which the sperm are produced is called spermatogenesis.	The structure in which spermatogenesis takes place is the seminiferous tubale. There are many seminiferous tubules in each testis. Human sperm have three main parts, a head which contains the nucleus, a middle piece, and tail (also called a flagellum) which helps the sperm swim from the vagina to the Fallopian tubes.
EPIDIDYMIS, VAS DEFERENS, EJACULATORY DUCT, URETHRA	are tubes through which the sperm move to pass out of the body.
The PROSTATE GLAND and SEMINAL VESICLE secrete fluid which is added to the sperm coming from the seminiferous tubules, and on its way to the penis.	Semen is sperm plus the fluids secreted by other structures of the male reproductive system.
The PENIS is the organ through which sperm are ejaculated from the body.	Ejaculation the process in which sperm pass from the penis. Usually millions of sperm are ejaculated at one time.

MASTERY TEST

Time Started: ______________________________

1. MATCH the columns below:

1. Fallopian tube	A. _____	egg develops here
2. ovary	B. _____	egg may be fertilized here
3. uterus	C. _____	fertilized egg embeds itself and develops here
4. vagina	D. _____	fetus passes through here at birth

2. The structure in which the unfertilized sex cell develops in the female is:

   a. ☐ the Graafian follicle

   b. ☐ the Fallopian tube

   c. ☐ the vagina

   d. ☐ the uterus

3. If fertilization occurs, the fertilized egg embeds itself in the:

   a. ☐ ovary

   b. ☐ Fallopian tube

   c. ☐ lining of the uterus

   d. ☐ vagina

4. Spermatogenesis is the process of:

   a. ☐ ejaculation of sperm
   b. ☐ fertilization of an egg cell by sperm
   c. ☐ production of sperm
   d. ☐ storage of sperm

5. Spermatogenesis occurs in the:

   a. ☐ penis
   b. ☐ testes
   c. ☐ urethra
   d. ☐ prostate gland

6. About how many sperm are released during an ejaculation?

   a. ☐ one
   b. ☐ twelve
   c. ☐ millions

Time completed ______________

WHEN YOU HAVE FINISHED THIS TEST, WRITE DOWN THE TIME. THEN TAKE THE LESSON TO YOUR INSTRUCTOR OR HIS ASSISTANT FOR CHECKING. WAIT UNTIL THE LESSON IS APPROVED BEFORE GOING ON TO THE NEXT LESSON.

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ADVANCED GENERAL EDUCATION PROGRAM

A HIGH SCHOOL SELF-STUDY PROGRAM

GENETICS AND HEREDITY
LEVEL: III
UNIT: 3
LESSON: 8

U.S. DEPARTMENT OF LABOR
MANPOWER ADMINISTRATION, JOB CORPS
NOVEMBER 1969

U.S. DEPARTMENT OF LABOR
MANPOWER ADMINISTRATION, JOB CORPS
NOVEMBER 1969

1. PREVIEW FRAME In the last lesson you learned about the ways the characteristics of organisms are passed from parents to offspring in the process of reproduction. In this unit you will learn more about the physical basis of heredity. You will also study some of the basic laws of heredity which allow scientists to predict the inheritance of specific characteristics. NO RESPONSE REQUIRED	GO ON TO THE NEXT FRAME
2. In the preceding lesson you learned that the basic characteristics of an organism are determined by: ☐ the vacuoles in the cells of the organism ☐ the chromosomes in the cells of the organism	the chromosomes in the cells . . .
These cellular structures are transmitted from the parent organism(s) to the offspring in the process of: ☐ absorption ☐ excretion ☐ reproduction ☐ respiration	reproduction

3.	
During the process of sexual reproduction, the offspring develops from the zygote, which is formed as a result of:	
☐ the mitotic division of the male gamete	
☐ the mitotic division of the female gamete	
☐ the union of the male and female gametes	the union of the male and . . .
☐ the process of fertilization	the process of fertilization
In the process of sexual reproduction the male and female sex cells each carry a number of chromosomes equal to:	
☐ half the number of chromosomes in the zygote	half the number of . . .
☐ the number of chromosomes in the zygote	
☐ twice the number of chromosomes in the zygote	
4.	
In sexual reproduction, each parent contributes the same number of chromosomes to the zygote. Also, each of the parents contributes chromosomes which determine each of the basic traits that will be transmitted from parents to offspring.	
For example, if the male gamete of an organ contains seven chromosomes, then we know that the female gamete will contain:	
☐ 14 chromosomes	
☐ seven chromosomes	seven chromosomes
☐ four chromosomes	
The male gamete contains a chromosome which determines hair color. The female gamete:	
☐ also contains a chromosome which determines hair color	also contains a chromosome . . .
☐ does not contain a chromosome which determines hair color	

5.	
From what you have learned in these frames, you could guess that in the zygote each chromosome from the male gamete:	
☐ is paired with a corresponding chromosome from the female gamete	is paired with a . . .
☐ is not paired with a corresponding chromosome from the female gamete	
You could also guess that each basic trait which is found in an organism with two parents:	
☐ is a result of the combined action of the chromosomes from both parents	is a result of the combined . . .
☐ is the result of the action of the chromosome from the male parent only	

6.	
In humans a sperm cell contains 23 chromosomes. A human ovum contains: ☐ 23 chromosomes ☐ 46 chromosomes ☐ 92 chromosomes	23 chromosomes
The human zygote contains: ☐ 23 paired sets of chromosomes ☐ 46 paired sets of chromosomes ☐ a set of 23 chromosomes from one parent ☐ a set of 46 chromosomes from one parent	23 paired sets of chromosomes
All cells in the human body, (except gametes) contain: ☐ 23 paired sets of chromosomes ☐ 46 paired sets of chromosomes ☐ a single set of 46 unpaired chromosomes	23 paired sets of chromosomes
In humans, the basic trait of eye color is determined by the action of: ☐ a pair of chromosomes ☐ a single chromosome	a pair of chromosomes

7.	
Human gametes contain:	
☐ a set of 23 unpaired chromosomes	a set of 23 unpaired chromosomes
☐ a set of 46 unpaired chromosomes	
☐ a set of 23 paired chromosomes	
☐ a set of 46 paired chromosomes	
Each cell of the human body, (except gametes), contains:	
☐ a set of 23 paired chromosomes	
☐ a set of 46 paired chromosomes	
☐ two paired sets, each with 23 chromosomes	. . . each with 23 chromosomes
☐ two paired sets, each with 46 chromosomes	
Each basic trait transmitted from the parents to the offspring is always determined by:	
☐ the interaction of chromosomes from both parents	the interaction of . . .
☐ the action of chromosomes from the male parent only	
☐ the action of chromosomes from the female parent only	
8.	
You have learned that the basic traits which are transmitted from parents to offspring are determined by chromosomes. Each chromosome is composed of complex chemical compounds arranged in long chain-like molecules. You would guess that the compounds:	
☐ determine the basic traits of the organism	determine the basic traits . . .
☐ do not determine the basic traits of the organism	

9. The material of which each chromosome is composed is a sugar acid, deoxyribonucleic acid, often called DNA, a name derived from the underlined letters in the full name. Deoxyribonucleic acid, or DNA,: ☐ determines the basic traits of the organism ☐ does not determine the basic traits of the organism DNA is a substance composed of chemical compounds arranged in: ☐ small sphere-like molecules ☐ long chain-like molecules	determines the basic traits . . . long chain-like molecules
10. The material of which chromosomes are composed is: ☐ beribonucleic acid, known as BNA ☐ deoxyribonucleic acid, known as DNA ☐ made up of compounds arranged in small sphere-like molecules ☐ made up of compounds arranged in long, chain-like molecules	deoxyribonucleic acid, . . . made up of compounds arranged in long ...

11.	
Suppose that one part of a chromosome of some organism influences hair color, while another part of the same chromosome influences eye color. Now, each chromosome in an organism usually determines or influences more than one basic trait. This suggests that the two traits are determined by:	
☐ the same part of the chain of DNA molecules which makes up the chromosome	
☐ two different parts of the chain of DNA molecules which makes up the chromosome	two different parts of the . . .
12.	
The different parts of the chain of DNA molecules which makes up any chromosome are called genes.*	
Different genes on one chromosome can only determine:	
☐ one and the same trait	
☐ different traits	different traits
The study of the relationships between genes and the basic traits of organisms is called genetics.	
The study of chromosomes:	
☐ is not part of genetics	
☐ is part of genetics	is part of genetics
*Genes, from the Greek word for family because children get their looks, height, etc. from parents and grand-parents.	

13.	
Genes are:	
☐ different parts of a chain of DNA which determine different traits	. . . different traits
☐ larger than chromosomes	
☐ parts of chromosomes	parts of chromosomes
☐ parts of cytoplasm	
☐ parts of the nucleus of any cell	parts of the nucleus of any cell
Genetics is:	
☐ the study of the relationship between the genes and the basic traits of an organism	. . . the relationship . . .
☐ the study of the structure of an organism	
14.	
In the preceding unit on genetics, you learned some of the basic facts about the role of chromosomes, genes, and DNA in the inheritance of traits.	
In this unit you will learn some of the laws of heredity through which the inheritance of traits can be predicted and even controlled.	
NO RESPONSE REQUIRED	GO ON TO THE NEXT FRAME

15. In the mid-1800's an Austrian monk named Gregor Mendel started the scientific study of genetics with some simple but very important experiments. Many of Mendel's conclusions have been proven true and are part of the "laws of genetics" as we know them today. The scientific study of genetics:	
☐ began at least 100 years ago ☐ began in recent years	began at least 100 years ago
Mendel's experimental findings:	
☐ have since been proven correct ☐ have since been proven wrong	have since been proven correct
16. Mendel's experiments were done with garden peas. As you know:	
☐ plants have chromosomes as do animals ☐ plants, unlike animals, don't have chromosomes	plants have chromosomes . . .
so that the results of experiments done with garden peas:	
☐ might also apply to animal heredity ☐ would have nothing to do with animal heredity	might also apply to animal . . .
17. You have already learned that chromosomes are found in pairs, one chromosome from each parent. From this it follows that if one chromosome has a gene for a certain trait, the other chromosome:	
☐ will also have a gene for that trait ☐ will not have a gene for that trait	will also have a gene for that trait

18.	
For every trait that an individual has there are at least two genes.	
These genes are found:	
☐ on one of each of the chromosomes of a chromosome pair	on one of each of the . . .
☐ on the same chromosome	
19.	
Mendel's studies were done:	
☐ in the 1800's	in the 1800's
☐ in the 1900's	
These experimental findings have since been found to be:	
☐ correct	correct
☐ incorrect	
For every trait an individual has there:	
☐ are two genes	are two genes
☐ is one gene	
found:	
☐ on one chromosome	
☐ on one of each of the chromosomes of a chromosome pair	on one of each of the . . .

20.	
Mendel learned that certain traits are dominant or strong, and certain traits are recessive or weak. When an individual has a gene for a dominant trait and a gene for a recessive trait, only the dominant trait will be seen. This is known as the Law of Dominance.	
If a gene for blue eye color (a recessive trait) and a gene for brown eye color (a dominant trait) are combined in the same individual, according to the Law of Dominance, his eyes will actually be:	
☐ blue ☐ brown	brown
This is why there are more people with:	
☐ brown eyes ☐ blue eyes	brown eyes
than with:	
☐ brown eyes ☐ blue eyes	blue eyes
21.	
If an individual has one dominant gene and one recessive gene for the same trait, which trait will be seen?	
☐ the trait carried by the dominant gene ☐ the trait carried by the recessive gene	. . . the dominant gene
This is known as the:	
☐ "Law of Heredity" ☐ "Law of Dominance"	"Law of Dominance"

22. According to Mendel's Law of Dominance, when an individual has one dominant gene and one recessive gene for the same trait, which trait will actually be seen? ☐ the dominant trait ☐ the recessive trait	the dominant trait
23. In the "short hand" of genetics, a dominant trait is represented by a capital letter and a recessive trait by a small letter. The following are some traits of the garden peas Mendel experimented with. Which traits are dominant and which are recessive?	

TRAIT	Dominant	Recessive	Dominant	Recessive
smooth seeds (R)	☐	☐	☒	☐
wrinkled seeds (r)	☐	☐	☐	☒
yellow color (g)	☐	☐	☐	☒
green color (G)	☐	☐	☒	☐
tall plant (T)	☐	☐	☒	☐
short plant (t)	☐	☐	☐	☒

24. If you are reading about the genetic make-up of a plant with respect to height and you see the following: tall plant (T) short plant (t) which trait would you suppose to be determined by the dominant gene? ☐ shortness ☐ tallness	tallness

25. If a plant has one gene for green color and one gene for yellow color and the actual color of the plant is green, you might assume that the gene for: ☐ yellow color is dominant ☐ green color is dominant ☐ yellow color is recessive ☐ green color is recessive	green color is dominant yellow color is recessive
26. If a plant carries one gene for smooth seeds (R) and one gene for wrinkled seeds (r) the seeds of the plant will be: ☐ smooth ☐ wrinkled	smooth
27. When an individual inherits one dominant trait and one recessive trait, the individual is called a hybrid. In a hybrid individual the actual trait that will be seen is the: ☐ dominant trait ☐ recessive trait	dominant trait
28. If you read that some of the garden peas Mendel studied had hybrid seed shape, you would assume that they have: ☐ one gene for smooth seeds (R) and one gene for wrinkled seeds (r) ☐ two genes for smooth seeds (R) ☐ two genes for wrinkled seeds (r)	one gene for smooth seeds . . .

29.	
If you inherited a gene for blue eyes (recessive) from your mother and a gene for brown eyes (dominant) from your father, your genetic make-up for eye color:	
☐ is hybrid ☐ isn't hybrid	is hybrid
30.	
When an individual is hybrid for a certain trait, he has:	
☐ two dominant genes for this trait ☐ two recessive genes for this trait ☐ one dominant and one recessive gene for this trait	one dominant and one . . .
According to the Law of Dominance, which trait will be seen in this individual?	
☐ the dominant trait ☐ the recessive trait	the dominant trait

31. Considering the genetic make-up of a garden pea with respect to the shape of its seeds, the plant may inherit a gene for smooth seeds (R) or for wrinkled seeds (r) from each parent. If the plant inherits one (R) from each parent so that it now has two genes for smooth seeds, its genetic make-up is written (RR). If the plant inherits one (r) from each parent how would you think the genetic make-up could be written? ☐ RR ☐ rr ☐ Rr	rr
If the plant inherits one (r) from one parent and one (R) from the other, how would you think the genetic make-up could be written? ☐ RR ☐ rr ☐ Rr	Rr
32. If the genetic make-up of a garden pea is written (RR) this means that the plant has: ☐ two recessive genes ☐ one recessive gene, one dominant gene ☐ two dominant genes	two dominant genes
33. If a garden pea has one recessive gene, for wrinkled seeds, and one dominant gene, for smooth seeds, how would you write its genetic make-up? __________	Rr
Which of the following plants is hybrid for seed shape? ☐ RR ☐ Rr ☐ rr	Rr

34.	
You have learned that a hybrid individual resembles the parent which has the: ☐ dominant gene ☐ recessive gene	dominant gene
35.	
Brown eye color is dominant over blue eye color, so that if you are hybrid with regard to eye color (one "brown" gene and one "blue" gene) your eyes will be __________.	brown
If you have two genes for brown eye color and none for blue, what color will your eyes be? __________	brown
If you have two genes for blue eye color and none for brown, what color will your eyes be? __________	blue
36.	
If you have two recessive genes for a trait, you: ☐ will develop this trait ☐ will not develop this trait	will develop this trait
If you have two dominant genes for a trait, you: ☐ will develop this trait ☐ will not develop this trait	will develop this trait
If you have one dominant gene and one recessive gene for a trait, which will develop? ☐ the dominant trait ☐ the recessive trait	the dominant trait

37.

Suppose we repeat Mendel's experiment with garden peas. First we will see what happens when 2 plants which look quite different are mated. The trait we will study is seed shape which may be either smooth (R) or wrinkled (r).

One parent has 2 genes for smooth seeds (RR); the other parent has 2 genes for wrinkled seeds (rr). We know that 1 gene from each parent will be found in the offspring. To figure out all the possible combinations, we draw the following table:

parent 1

parent 2

	r	r
R	Rr	Rr
R	Rr	Rr

offspring

offspring

If the parents are RR and rr, the offspring will be:

☐ all RR
☐ all Rr
☐ all rr
☐ partly Rr, RR, and rr

all Rr

38.

If two plants with the genetic make-up (RR smooth) and (rr wrinkled) for seed shape are crossed, all the offspring will be Rr.

According to the Law of Dominance, the actual seed shape of the offspring will be:

☐ smooth
☐ wrinkled

smooth

This means that traits carried by the genes inherited from the (rr) parent will:

☐ be hidden in the offspring
☐ be seen in the offspring

be hidden in the offspring

39.	
If two garden pea plants with (RR) and (rr) genes for seed shape are mated, all the offspring:	
☐ will be hybrid for this trait ☐ will not be hybrid for this trait	will be hybrid for this trait
Which means that:	
☐ the dominant trait (R) will be seen in all the offspring	the dominant trait (R) will . . .
☐ the recessive trait (r) will be hidden in all the offspring	the recessive trait (r) will . . .

40.

Let's now mate 2 of these hybrid garden peas each of which has the genetic make-up (Rr) for seed shape and see what possible combination of genes the offspring can have.

		Parent 1	
		R	r
Parent 2	R	RR	Rr
	r	Rr	rr

In considering the diagram above you should remember that a single gamete from either of the parents carries only one gene for seed shape. Thus each parent can produce:

☐ two different types of gametes; one type carries a dominant gene and the other carries a recessive gene	two different types of . . .
☐ only one type of gamete. The table above shows the possible genetic make-up of the offspring	
☐ each of two types of gametes from one parent can combine with each of two types of gametes from the other parent	each of two types of . . .
☐ each of two types of gametes from parent 1 can combine with only one type from parent 2	
☐ the single type of gamete from parent 1 can combine with the single type of gamete from parent 2	

41.

Parent 1

		R	r
Parent 2	R	RR	Rr
	r	Rr	rr

The table above shows the possible genetic make-up of the offspring by summarizing how each of two types of gametes from one parent can combine with each of two types of gametes from the other parent.	
Thus, an (R)-bearing gamete from parent 1 can possibly combine with:	
☐ either an (R) or an (r) from parent 2 ☐ only an (R) from parent 2 ☐ only an (r) from parent 2	either an (R) or an (r) from . . .
Similarly, an (r) from parent 1 can possibly combine with:	
☐ either an (R) or an (r) from parent 2 ☐ only an (R) from parent 2 ☐ only an (r) from parent 2	either an (R) or an (r) from . . .
The table has four cells for entries, each of which shows the genetic make-up of one possible offspring.	
How many genetically different types of offspring are shown in the table?	
☐ 1 ☐ 2 ☐ 3 ☐ 4	3

42.

Parent 1

		R	r
Parent 2	R	RR	Rr
	r	Rr	rr

It has been found that of the four cells in the genetic combination the table has the same chance of occurring in the offspring as similarly classed gametes.

Thus, if we look at a large number of offspring of mated (Rr) parents, we will probably find that there are:

- ☐ about as many (RR) offspring as (rr) offspring
- ☐ many more (RR) offspring than (rr) offspring
- ☐ many more (rr) offspring than (RR) offspring

about as many (RR) . . .

43.

		Parent 1	
		R	r
Parent 2	R	RR	Rr
	r	Rr	rr

If we could examine the genetic make-up of a large number of offspring of the mating shown above, we would find that there would probably be as many (RR) offspring as (rr) offspring.

Thus, in a batch of 100 offspring there would probably be about 25 (RR) offspring. How many (rr) would there probably be?

☐ 1/4 of the total number of offspring
☐ 1/2 of the total number of offspring

The combinations (RR) and (rr) each occur once in the table. The combination (Rr) occurs twice. You would thus expect that in any large number of offspring, there would probably be about:

☐ as many (Rr) offspring as (RR) offspring

☐ half as many (Rr) offspring as (rr) offspring

☐ twice as many (Rr) offspring as either (RR) or (rr) offspring

In a batch of 100 offspring you would expect to find about:

☐ 25 (Rr) offspring
☐ 50 (Rr) offspring
☐ 75 (Rr) offspring

1/4 of the total number . . .

twice as many (Rr) offspring . . .

50 (Rr) offspring

44.

Parent 1

		R	r
Parent 2	R	RR	Rr
	r	Rr	rr

If we mate 2 garden peas hybrid for seed shape, what fraction of the offspring will probably also be hybrid?

☐ 1/4
☐ 1/2
☐ 3/4

1/2

What fraction of the offspring, if any, will have 2 similar genes for seed shape?

☐ 1/4
☐ 1/2
☐ none

1/2

45.

Parent 1

Parent 2		R	r
	R	RR	Rr
	r	Rr	rr

Both parents in the diagram above are hybrid for seed shape. Both parents have:

☐ smooth seeds (R)
☐ wrinkled seeds (r)

smooth seeds (R)

Is it possible for these parents to produce offspring with wrinkled seeds?

☐ yes
☐ no

yes

46.

If 2 hybrid garden peas are mated 1/4 of the offspring will probably have 2 genes for the recessive trait.

This means that 2 parents who look alike:

☐ can produce offspring who look different from both parents

☐ cannot produce offspring who look different from both parents

can produce offspring who . . .

47. The experiment we have just studied was done by Mendel. He found, as we did, that the recessive trait which was hidden in the hybrid parent: ☐ can reappear in later generations ☐ can never reappear in later generations	can reappear in later generations
48. "When 2 hybrid individuals are mated, the recessive trait, which has been hidden in the hybrids is separated (or segregated) from the dominant trait. There is a chance for two recessive genes to recombine so that the recessive trait will reappear in some offspring of the next generation." This is a restatement of Mendel's Law of Segregation and Recombination. According to Mendel's Law of Segregation and Recombination, if we mate 2 smooth-seeded garden peas which we know to be hybrid for seed shape: ☐ all of the offspring will have smooth seeds ☐ most offspring will have smooth seeds but some will have wrinkled seeds	most offspring will have . . .
49. In order for a recessive trait to show up in an individual, 2 recessive genes must be present for that trait. According to Mendel's Law of Segregation and Recombination, this recessive trait can appear: ☐ even if both parents have only 1 recessive gene for this trait ☐ only if both parents have 2 recessive genes for this trait	even if both parents . . .

50.	
We can apply Mendel's Law of Segregation and Recombination to human heredity as well as to garden peas.	
Lets assume that your maternal grandmother (your mother's mother) has blue eyes. Her genetic make-up for eye color is (bb) indicating that she has:	
☐ 2 dominant genes for eye color ☐ 2 recessive genes for eye color	2 recessive genes for eye color
If your maternal grandfather's eyes are brown (brown being the dominant eye color) his genetic make-up for eye color:	
☐ could only be (BB) ☐ could be (BB) or (Bb)	could be (BB) or (Bb)
Let's assume your grandfather has brown eyes (BB) indicating that he has:	
☐ 2 dominant genes for eye color ☐ 2 recessive genes for eye color	2 dominant genes for eye color

51.

When your grandparents married, they had 4 children. The diagram below shows the genetic make-up of their children for eye color.

(B = brown and b = blue)

grandfather

		B	B	
grand-mother	b	Bb	Bb	children
	b	Bb	Bb	

children

Your grandparent's children (your mother and her brothers and sisters):

☐ all have blue eyes
☐ all have brown eyes
☐ are partly blue-eyed and partly brown-eyed
☐ are partly hybrid for eye color
☐ are all hybrid for eye color

all have brown eyes

are all hybrid for eye color

52.

If your grandmother was (bb) for eye color and your grandfather was (BB) all of their children will be brown-eyed hybrid with the genetic make-up:

☐ BB
☐ Bb
☐ bb

Bb

53.

One of these children is your father. Let's say he marries a woman who has the same genetic make-up as he for eye color. That is, both your father and mother have one gene for brown eyes and one for blue eyes: both parents have brown eyes.

Now, let's see what your eye color might be.

father

mother

	B	b
B	BB	Bb
b	Bb	bb

children

children

Your eye color:

☐ could only be brown
☐ could be brown or blue
☐ could only be blue

could be brown or blue

54.

If your parents both have brown eyes it is:

☐ possible
☐ impossible

for you to have blue eyes.

possible

The genetic law which explains this is known as Mendel's:

☐ Law of Dominance
☐ Law of Segregation and Recombination

Law of Segregation and . . .

55.

Mendel performed some experiments in which he observed what happened to two completely different characteristics of garden peas when the plants were mated. If we repeat this experiment we could select plant height and pod color as the characteristics we will observe.

From what you have already learned, decide which traits are dominant and which are recessive.

	dominant	recessive	dominant	recessive
Plant Height:				
Tall (T)	☐	☐	☒	☐
Short (t)	☐	☐	☐	☒
Pod color:				
Yellow (g)	☐	☐	☐	☒
Green (G)	☐	☐	☒	☐

56.

If we mate a great many garden peas and observe the heights and pod colors, we will find that any of the following combinations is possible, with each combination of height genes matched with each combination of color genes:

TT	GG
TT	Gg
TT	gg
Tt	GG
Tt	Gg
Tt	gg
tt	GG
tt	Gg
tt	gg

From these results, you might conclude that the genes for plant height and pod color are inherited:

☐ independently of one another - all types of genetic patterns are possible

☐ in one genetic pattern that is always the same

independently of one another . . .

57.	
If a tall garden pea plant with two genes for yellow pods (recessive trait) is mated with a tall garden pea plant with two genes for green pods (dominant trait) the offspring will be tall and will have:	
☐ yellow pods ☐ green pods	green pods
From this you might conclude that the genes for tallness and the genes for green pod color:	
☐ can be inherited independently of one another	can be inherited independently . . .
☐ cannot be inherited independently of one another	
58.	
You have just learned another of Mendel's laws: the Law of Independent Assortment.	
The Law of Independent Assortment states that:	
☐ genes for different characteristics are inherited independently of one another	. . . independently of one . . .
☐ genes for different characteristics are always inherited in a definite relationship to one another	
59.	
One of Mendel's laws states that: "The genes for each characteristic of an organism are inherited independently of one another."	
This is known as the:	
☐ Law of Dominance ☐ Law of Segregation and Recombination ☐ Law of Independent Assortment	Law of Independent Assortment

60. Although Mendel's Law of Independent Assortment holds true in most cases there are certain traits which are inherited together. Mendel's Law of Independent Assortment holds true: ☐ always ☐ never ☐ usually	usually
61. Mendel concluded that all genes are either recessive or dominant. A German scientist named Carl Correns found this usually but not always true. Carl Correns found that Mendel's conclusions about all genes being either recessive or dominant were: ☐ completely wrong ☐ always correct ☐ correct in most but not all cases	correct in most but not all cases
62. Correns, like Mendel, experimented with plants. Correns used flowers called four o'clocks.* We can repeat Correns experiments by mating a red four o'clock with a white four o'clock. Since red is the dominant color in many plants you would expect the offspring to be: ☐ all white ☐ all red *Four o'clocks, because the blossoms open in the late afternoon.	all red

63. Mating a red four o'clock plant with a white one produces a pink four o'clock. This is: ☐ what you would expect to happen according to what you have learned ☐ contrary to what you would expect to happen according to what you have learned	contrary to what you would . . .
64. In the case of four o'clock plants, neither red nor white color is completely dominant over the other. When red and white are mated, the resulting pink color indicates that: ☐ one color has dominated over the other ☐ the two colors have blended with one another ☐ neither color is completely dominant	the two colors have blended . . . neither color is completely . . .
65. Correns discovered that mating red with white four o'clocks yields pink offspring. This pink color is a blend of the two colors of the parents. In the case of four o'clocks: ☐ red color is dominant ☐ white color is dominant ☐ both red and white color are incompletely dominant ☐ the genes for red and white color produce a blend of the two colors	both red and white color are . . . the genes for red and white . . .

66.

The case of blending colors in four o'clocks is an example of blending inheritance. As you might assume, blending inheritance occurs when:

☐ there is one dominant and one recessive gene for contrasting traits

☐ two genes for contrasting traits are both incompletely dominant

two genes for contrasting . . .

67.

When 2 genes for contrasting traits (for example, for red versus white color in the four o'clock plant) are both incompletely dominant the offspring will have:

☐ either one trait or the other
☐ a blend of the two traits

a blend of the two traits

This is called:

☐ blending inheritance
☐ the Law of Dominance

blending inheritance

Time completed ______________

YOU HAVE NOW FINISHED THE FIRST PART OF THIS LESSON. WRITE DOWN THE TIME. THEN, AFTER YOU HAVE REVIEWED THE MAIN IDEAS IN THE FOLLOWING SUMMARY, TAKE THE MASTERY TEST AT THE END OF THE BOOKLET.

The fertilized ovum, the ZYGOTE, contains a set of paired chromosomes. One half of this is from the male gamete, the other half is from the female gamete. The basic characteristics of the zygote are determined by the interaction of the chromosomes from both parents.	
CHROMOSOMES are composed of a substance called desoxyribonucleic acid, known simply as DNA.	DNA is a chain of complex protein molecules. The different parts of the chain of DNA molecules, that make up any chromosome are called genes.
GENETICS is the study of the relationships between genes and the basic traits of organisms.	
For every trait that an organism has, there are two genes, one from the male gamete and one from the female gamete.	A gene for a dominant trait is indicated by a capital letter; (B) a gene for a recessive trait is indicated by a small letter (b).
A HYBRID is an individual with one gene for the dominant trait and one gene for the recessive trait for example (Bb).	Individuals may have two genes for the dominant trait (BB), two genes for the recessive trait (bb), or one gene for the dominant trait and one gene for the recessive trait (Bb).
According to Mendel's LAW OF DOMINANCE: when an individual has a gene for a dominant trait and a gene for a recessive trait, only the dominant trait will be seen.	Example: an individual who inherits a gene for brown eye color (B), a dominant trait, and a gene for blue eye color (b), a recessive trait, will have brown eyes. (Genetic makeup denoted by Bb).
	Individuals who have two genes for a dominant trait (BB) develop the dominant trait.
	Individuals who have two genes for a recessive trait (bb), develop the recessive trait.
	Individuals who have one gene for a dominant trait and one gene for a recessive trait (Bb), develop the dominant trait.

If BB parent is mated with a bb parent, the offspring will probably be Bb .	Thus, the recessive trait may not show up although it has been passed on to the next generation.
If two hybrid parents (Bb and Bb) mated, 25% of the offspring produced will probably be BB, 25% bb, and 50% Bb.	Thus, the recessive trait hidden in a previous generation may show up in a later generation.
According to Mendel's LAW OF SEGREGATION AND RECOMBINATION when two hybrid individuals are mated there is a chance that the gene for recessive trait will combine with another gene for the recessive trait thus producing an individual with two genes for the recessive trait.	Example: Bb mated with Bb may produce a bb individual.
According to Mendel's LAW OF INDEPENDENT ASSORTMENT, genes for different characteristics are inherited independently of one another.	Example: Brown eyes and brown hair are dominant traits whereas blue eyes and blond hair are recessive traits. An individual, however, may have brown eyes (the dominant trait) and blond hair (the recessive trait).
According to Corren's theory of blending inheritance, two genes for contrasting traits may be both incompletely dominant.	A pink 4 o'clock flower has genes for two dominant traits. In other words, it has the gene for white color (a dominant trait) and the gene for red color (a dominant trait). As a result, the flower is pink because both traits are incompletely dominant.

MASTERY TEST

Time started ______________

1.

A. ovum in humans

B. skin cell in humans

C. sperm cell in humans

MATCH the type of cell in the list above with one or more appropriate descriptions below:

1. _____ contains chromosomes from both parents

2. _____ contains chromosomes from one parent only

3. _____ contains 46 chromosomes

4. _____ contains only one set of 23 chromosomes

5. _____ contains 23 paired chromosomes

2. In humans, the gene for blue eyes (b) is recessive, while the one for brown eyes (B) is dominant.

A person carrying the genes (Bb) would have:

a. ☐ blue eyes

b. ☐ brown eyes

A person carrying genes (BB) would have:

a. ☐ blue eyes

b. ☐ brown eyes

A person carrying genes (bb) would have:

a. ☐ blue eyes

b. ☐ brown eyes

3. When an individual is a hybrid with respect to a certain trait he has:

   a. ☐ one dominant and one recessive gene for that trait

   b. ☐ two dominant genes for that trait

   c. ☐ two recessive genes for that trait

   d. ☐ only one gene, either dominant or recessive, for that trait

4. According to Mendel's Law of Segregation and Recombination a recessive trait may be seen in the offspring of two parents:

   a. ☐ only if both parents show the recessive trait

   b. ☐ when both parents are hybrids with respect to that trait

   c. ☐ when one parent has two dominant genes for the trait and the other has two recessive genes

   d. ☐ when one parent has two dominant genes and the other is a hybrid with respect to that trait

5. One of Mendel's laws of heredity states that the genes for each trait of an organism are inherited independently of one another. This law is called the:

   a. ☐ Law of Dominance

   b. ☐ Law of Independent Assortment

   c. ☐ Law of Independent Recessive

   d. ☐ Law of Segregation and Recombination

6. In blending inheritance:

- a. ☐ the two genes for a trait are both recessive genes
- b. ☐ the two genes for a trait are incompletely dominant
- c. ☐ the trait is controlled by only one gene

Time completed ________________

WHEN YOU HAVE FINISHED THIS TEST, WRITE DOWN THE TIME. THEN TAKE THE LESSON TO YOUR INSTRUCTOR OR HIS ASSISTANT FOR CHECKING. WAIT UNTIL THE LESSON IS APPROVED BEFORE GOING ON TO THE NEXT LESSON.

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ADVANCED
GENERAL EDUCATION PROGRAM

A HIGH SCHOOL SELF-STUDY PROGRAM

THE NERVOUS SYSTEM
LEVEL: III
UNIT: 3
LESSON: 9

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MANPOWER ADMINISTRATION, JOB CORPS
NOVEMBER 1969

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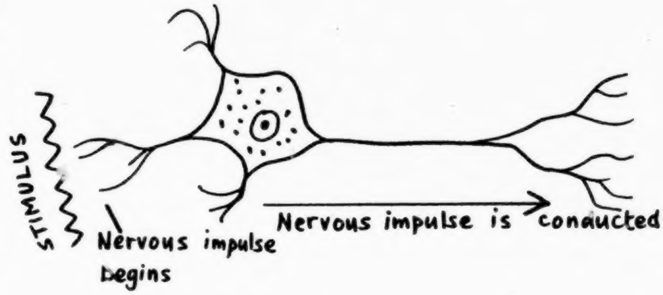
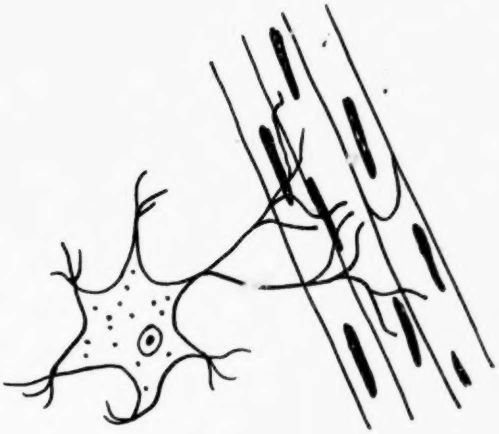
MANPOWER ADMINISTRATION, JOB CORPS
NOVEMBER 1969

1. PREVIEW FRAME As you learned in an earlier unit, the nervous system is responsible for the conduction of motor and sensory impulses. Thought, sensation, and action are all controlled by the nervous system. In this unit you will learn more about the structure and function of the nervous system. You will learn how "messages" from the outside environment are transmitted to the brain and how the brain then causes some part of the body to make a response. NO RESPONSE REQUIRED	GO ON TO THE NEXT FRAME
2. A *stimulus* is an event, sensation, or change, which causes a sensitive organism to *respond* in some way. For example, a sudden bright light may be a stimulus causing an eye to respond by blinking. LABEL each example below "S" or "R" to indicate that it is a *stimulus* or a *response*.	
______ a muscle contracting to prepare for striking a blow at a threatening person	R
______ the eye blinking	R
______ a strong bright light	S
______ a hot stove burning someone's hand	S
______ a hand suddenly pulling away from a hot stove which burned it	R

3.	
Nerve cells are different from other types of body cells in that they are extremely sensitive to stimuli. Some types of nerve cells are specialized to respond to certain stimuli. For example, special cells in the eye respond to the stimulus of light.	
Special sensitivity to stimuli is:	
☐ a characteristic of nerve cells ☐ not a characteristic of nerve cells	a characteristic of nerve cells
If an eye is suddenly exposed to a strong bright light, the eye will blink.	
The light is:	
☐ the response; the blinking is the stimulus ☐ the stimulus, the blinking is the response	the stimulus, the blinking . . .
4.	
When a nerve cell is stimulated in some way, it responds by conducting a nervous impulse from one end of the nerve cell to the other. Since nerve cells are often very long, the nervous impulse may be conducted a long way.	
Which two specialized functions do nerve cells have?	
☐ conduct impulses ☐ excrete body wastes	conduct impulses
☐ respond to stimuli ☐ secrete hormones	respond to stimuli

5.  STIMULUS Nervous impulse begins Nervous impulse is conducted The schematic illustration of a nerve cell above shows the basic functions of the nerve cell. What causes a nervous impulse to begin? ________________ What happens to the nervous impulse after it begins? ________________	a stimulus it is conducted
6. What are the two basic functions of a nerve cell? ________________ ________________	to respond to stimuli to conduct nervous impulses

7.	
	
The illustration above shows how the nerve cell is positioned with respect to a muscle cell.	
When a nervous impulse is conducted along the nerve cell and reaches the muscle cell, the muscle will contract.	
How does a muscle respond to a nervous impulse? ________________	by contracting
What causes the nerve cell to produce the nervous impulse? ________________	a stimulus
8.	
How do muscle cells respond to nervous impulse?	
☐ by contracting	by contracting
☐ by moving away from the nerve cell	
☐ they do not	

9. Gland cells have the special function of secreting chemical substances like saliva, perspiration, etc., depending on the type of gland. Most gland cells secrete in response to nervous impulses. In order for most hormones, saliva, perspiration and similar substances to be secreted by gland cells, what other type of cell is involved? ____________ What does this cell do which affects the gland cells? ____________	a nerve cell conducts a nervous impulse (or equivalent response)
10. What are the usual stimuli that evoke responses in muscle and gland cells? ____________	nervous impulses
11. Nervous tissue forms a "communications network" throughout the body so that almost every part of the body contains nerves. At the same time every portion of nervous tissue in the body is connected to other portions, so that it is all welded together in a great system called the nervous system. Nerves are found: ☐ only in the brain and the spine ☐ in almost every part of the body The various portions of the nervous system: ☐ are connected with one another ☐ are not connected with one another	in almost every part of the body are connected with one another

12.	
The parts which make up the nervous system are found:	
☐ only in the brain and the spinal cord ☐ throughout the body	throughout the body
Individual parts of the nervous system:	
☐ are connected and dependent upon other parts of the system	are connected and . . .
☐ are independent and separate from other parts of the system	
13.	
The major parts of the nervous system are the central nervous system, consisting of the brain and the spinal cord, and the peripheral nervous system*, consisting of nerves leading to and from the central nervous system.	
The major parts of the nervous system are:	
☐ one ☐ two ☐ four ☐ many	two
NAME the major part or parts of the nervous system:	
______________	the central nervous system (consisting of the brain and spinal cord),
______________	the peripheral nervous system
*Periphery (per-if-er-e) means the outer parts.	

14. The peripheral nervous system consists of nerves leading from various parts of the body to the brain or spinal cord and back again. Which of the following are parts of the peripheral nervous system? ☐ a nerve leading from a muscle in the leg to the spinal cord ☐ a nerve leading from one part of the brain to another ☐ a nerve leading from the spinal cord to the salivary glands ☐ a nerve leading from the spinal cord to the brain The nervous system as a whole consists of the peripheral nervous system and the ________ nervous system.	a nerve leading from . . . . . . to the salivary glands central
15. The brain and spinal cord form the ________.	central nervous system
16. The outer part of the body may be called the periphery of the body. This term should help you to remember that nerves leading from the brain or spinal cord to the outer part of the body are part of the ________ nervous system.	peripheral

17.	
NAME the two subdivisions of the nervous system:	
1. ______________	1. the central nervous system
2. ______________	2. the peripheral nervous system
18.	
Nerves which connect the spinal cord with the periphery of the body are called spinal nerves.	
Nerves extending from the brain to another part of the body, without passing through the spinal cord, are called cranial* nerves.	
The optic nerve connects the eye directly with the brain. The optic nerve is a:	
☐ cranial nerve ☐ spinal nerve	cranial nerve
Nerves which pass from the spinal cord to muscles in a leg are:	
☐ cranial nerves ☐ spinal nerves	spinal nerves
*Cranial is Latin for from the head (cranium)	

19. Cranial nerves and spinal nerves are part of the: ☐ central nervous system (CNS) ☐ peripheral nervous system (PNS) because they ☐ connect the central nervous system with the periphery of the body ☐ connect one part of the central nervous system with another	peripheral nervous system (PNS) connect the central nervous . . .
20. Nerve cells have the general functions of being especially responsive to stimuli and being able to conduct nervous impulses along their length. In addition, a nerve cell may have a more specialized function: it may receive stimuli from the outside world or it may cause a muscle or gland to respond. Which of the following do you think a motor nerve would be? ☐ a nerve which causes a muscle or gland to respond ☐ a nerve which receives stimuli	a nerve which causes a . . .

21.	
A nerve which causes a muscle or gland to respond is called a motor nerve.	
A nerve which receives stimuli from the outside world through the senses is called a sensory nerve.	
Which of the following would be sensory nerves ?	
☐ A nerve in the eye responds to a light stimulus.	A nerve in the eye . . .
☐ A nerve causes a muscle in the arm to contract.	
☐ A nerve in the ear responds to a sound stimulus.	A nerve in the ear . . .
☐ A nerve in the skin is responsible for our sensitivity to pain.	A nerve in the skin . . .
22.	
It is easy to remember the function of sensory nerves if you associate them with the 5 senses (hearing, sight, taste, touch, and smell).	
Similarly, if you think of the muscles as the "motors" of the body, you can easily remember the functions of motor nerves.	
The nerve associated with the sensitivity of the eyes to color is a:	
☐ motor nerve ☐ sensory nerve	sensory nerve
The nerve which enables us to distinguish high-pitched sounds from low-pitched sounds is a:	
☐ motor nerve ☐ sensory nerve	sensory nerve

23.

From what you have already learned, it should be clear that sensory nerves are part of the:

☐ central nervous system
☐ peripheral nervous system

and that motor nerves are part of the:

☐ central nervous system
☐ peripheral nervous system

peripheral nervous system

peripheral nervous system

24.

What are the two kinds of nerve cells of which peripheral nerves consist?

1. _______________
2. _______________

1. sensory nerves
2. motor nerves

25.

MATCH the following:

A. part of the central nervous system

B. part of the peripheral nervous system

1. _____ the cranial nerves
2. _____ nerves extending from the spinal cord to muscles and glands
3. _____ the brain
4. _____ the spinal cord
5. _____ the spinal nerves
6. _____ nerves receiving stimuli from the outside world and carrying these stimuli to other parts of the nervous system

1. B
2. B
3. A
4. A
5. B
6. B

26.

We have learned a few basic facts about the nervous system. As you might suppose, a complete study of the structure and function of the nervous system is very complex and well beyond the scope of this unit.

You can grasp the general idea of how the nervous system works by studying the "reflex arc."

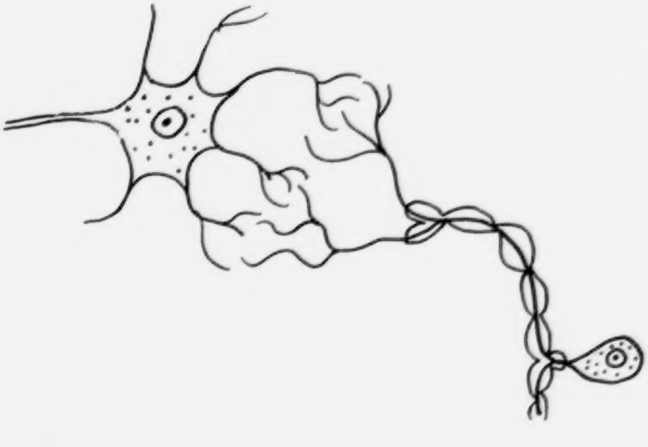
NO RESPONSE REQUIRED

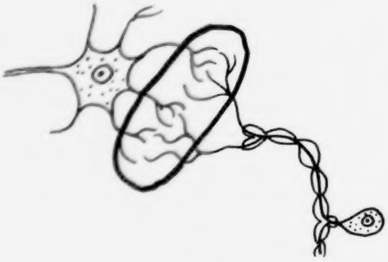
GO ON TO THE NEXT FRAME

27.

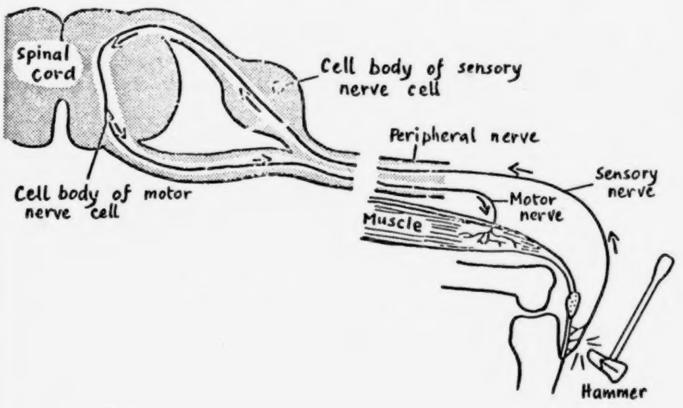
The word synapse (sin-aps) was derived from the Greek work meaning "to clasp." The contact point between two nerve cells is called a synapse.

CIRCLE the synapse between the 2 nerve cells shown below.

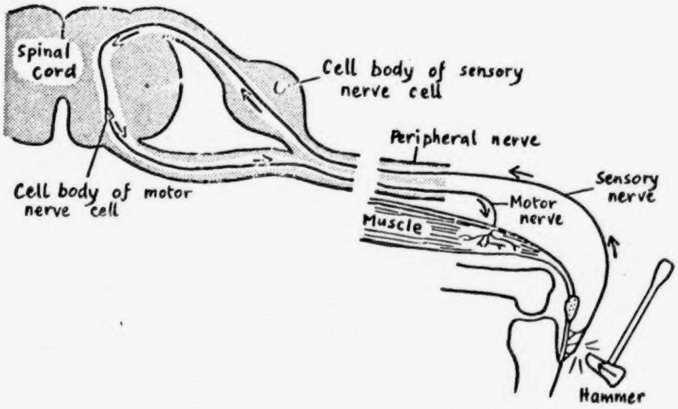




28.	
Nervous impulses pass across synapses.	
A synapse is:	
☐ the nucleus of a nerve cell ☐ the elongated part of a nerve cell ☐ the contact point between two nerve cells	the contact point between . . .
When one nerve "communicates" with another nerve, what actually passes from nerve to nerve?	
☐ a nervous impulse ☐ sound waves	a nervous impulse
29.	
Arrangements of two or more nerve tissues are usually needed if a stimulus received by a sensory nerve is to be transmitted to a motor nerve and cause a response in a muscle or gland. This arrangement of 2 or more nerve tissues so that an animal can respond to a stimulus is called a reflex arc.	
In a reflex arc, the communication point between 2 nerve cells is the:	
☐ cell body ☐ synapse	synapse
What is the least number of nerve cells possible in a reflex arc?	
☐ one ☐ two ☐ three	two

30.	
A reflex arc is composed of at least _____(how many) nerve cells.	2
The synapse is the communication point between nerve cells. What passes across the synapse? ☐ sound waves ☐ nervous impulse	nervous impulse
31.	
 Spinal cord Cell body of sensory nerve cell Peripheral nerve Sensory nerve Cell body of motor nerve cell Motor nerve Muscle Hammer	
The diagram above illustrates a simple reflex arc.	
How many synapses are present? ______________	one
Where is/are this/these synapses? ______________	in the spinal cord
How many nerve cells are present? ______________	two
Which parts of the nervous system are involved? ☐ C.N.S. only ☐ P.N.S. only ☐ both C.N.S. and the P.N.S.	both the C.N.S. and the P.N.S.

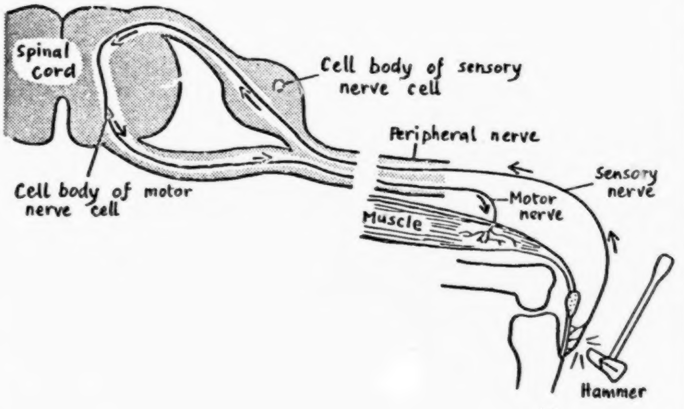
32.


Spinal cord
Cell body of sensory nerve cell
Peripheral nerve
Sensory nerve
Motor nerve
Muscle
Cell body of motor nerve cell
Hammer

It can be seen from the arrows in the diagram that the nervous impulse is carried toward the spinal cord by the: ☐ sensory nerve cell ☐ motor nerve cell	sensory nerve cell
What type of nerve cell carries the nervous impulse from the spinal cord to a muscle? ______________	motor nerve cell
Where does the synapse take place? ______________	in the spinal cord

33.	
How many nerve cells are involved in the simplest kind of reflex arc? ☐ one ☐ two ☐ three ☐ four	two
How many synapses are present? ______________	one
What passes across a synapse? ______________	a nervous impulse
Which parts of the nervous system were involved in the reflex arc sketched in the previous frame? ☐ C.N.S. only ☐ P.N.S. only ☐ both C.N.S. and P.N.S.	both C.N.S. and P.N.S.

34.

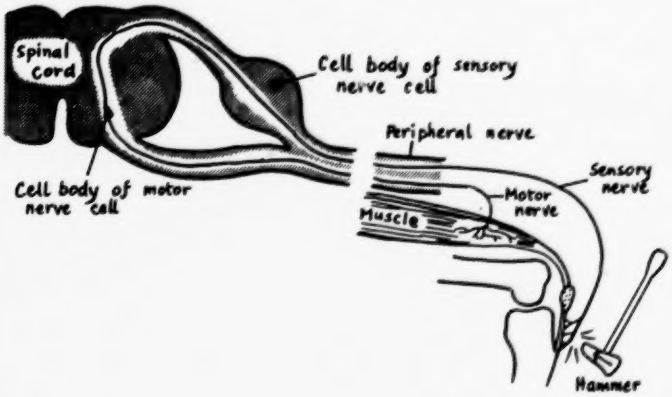

Spinal cord
Cell body of sensory nerve cell
Peripheral nerve
Sensory nerve
Cell body of motor nerve cell
Motor nerve
Muscle
Hammer

The name of the reflex arc shown above is the knee jerk reflex. When the hammer taps the part of the knee where the sensory nerve cell ends, a nervous impulse begins. The muscle in the diagram responds by contracting so that the lower leg jerks forward and upward.

What is the stimulus for the knee jerk reflex? ________________	the hammer blow on the knee
What is the response in the knee jerk reflex? ________________	the lower leg jerks forward and upward (or equivalent responses)

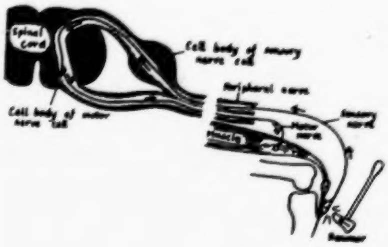
35. In the knee jerk reflex, the sensory nerve cell receives the stimulus in: ☐ the spinal cord ☐ the knee The muscle responds by contracting because of a nervous impulse it receives from the: ☐ sensory nerve cell ☐ motor nerve cell	the knee motor nerve cell
36. In the knee jerk reflex the contraction of a leg muscle is the: ☐ stimulus ☐ response The minimum number of nerve cells involved in this reflex is ______.	response 2

37.


Spinal cord
Cell body of sensory nerve cell
Peripheral nerve
Sensory nerve
Cell body of motor nerve cell
Motor nerve
Muscle
Hammer

What part of the central nervous system is involved in the knee jerk reflex? ________________

With a pencil trace the direction of the nerve impulse from the moment it is initiated by the hammer stimulus until it causes the muscle to contract in response.


Spinal Cord
Cell body of sensory nerve cell
Peripheral nerve
Sensory nerve
Cell body of motor nerve cell
Motor nerve
Muscle
Hammer

the spinal cord

38. The simple knee jerk reflex is an example of how more complex nerve reflexes occur. For example, sensory nerve cells always carry the nervous impulse: ☐ toward the spinal cord ☐ away from the spinal cord	toward the spinal cord
What type of nerve cell carries the impulse in the opposite direction? ______________	the motor nerve cell
39. The knee jerk reflex involves _____ (how many) nerve cells.	2
What kinds of nerve cells are involved? ☐ one sensory and one motor nerve cell ☐ two motor nerve cells ☐ two sensory nerve cells	one sensory and one . . .
What part of the C.N.S., if any, is involved in the reflex? ______________	the spinal cord
	Time completed ______________

YOU HAVE NOW FINISHED THE FIRST PART OF THIS LESSON. WRITE DOWN THE TIME. THEN, AFTER YOU HAVE REVIEWED THE MAIN IDEAS IN THE FOLLOWING SUMMARY, TAKE THE MASTERY TEST AT THE END OF THE BOOKLET.

The two specialized functions of nerve cells are irritability and conduction. Thus, nerve cells are extremely sensitive to stimuli; they respond by conducting a nervous impulse.	A stimulus is an event, sensation, or change which causes an organism to respond in some way. Example: A sudden bright light is a stimulus to certain cells in the eye. A typical response to this stimulus is blinking.
Most nerve cells respond to stimuli by producing nervous impulses.	Muscle cells respond to nervous impulses by contracting.
The main parts of the nervous system are: 1. the central nervous system (cns) and the 2. peripheral nervous system (pns) a) spinal nerves b) cranial nerves	1. The cns consists of the brain and the spinal cord. 2. The pns consists of nerves leading from various parts of the body to the brain or spinal cord and back again. a) Nerves which connect the spinal cord with the periphery of the body are called spinal nerves. b) Nerves extending from the brain to another part of the body, without passing through the spinal cord, are called cranial nerves.
Nerve cells may specialize in their ability to receive stimuli or in their ability to respond.	Sensory nerve is a nerve which receives stimuli from the outside world through the senses. Motor nerve is a nerve which causes a muscle or gland to respond. Sensory and motor nerves are part of the peripheral nervous system.
SYNAPSE	is the contact point between two nerve cells over which a nervous impulse passes.
REFLEX ARC	is an arrangement of at least two types of nerve cells and a synapse: one type of nerve cell receives the stimulus (sensory nerve), and the other type causes a response (motor nerve).

MASTERY TEST

Time started ______________

1. What are the two specialized functions of any nerve cell ?

   a. ☐ excretion of wastes and conduction of impulses

   b. ☐ excretion of wastes and secretion of hormones

   c. ☐ secretion of hormones and conduction of impulses

   d. ☐ sensitivity of stimulation and conduction of impulses

2. The stimuli that usually cause responses in muscle or gland cells:

   a. ☐ are nervous impulses

   b. ☐ are produced within the muscle or gland cells themselves

   c. ☐ travel to these cells through the blood

   d. ☐ are unknown

3. A. central nervous system

   B. peripheral nervous system

   MATCH each of the names above to the appropriate description(s) below:

   1. ______ cranial and spinal nerves

   2. ______ nerves connecting the brain with the spinal cord

   3. ______ nerves found in the arms

   4. ______ nerve leading from the ear to the brain

   5. ______ nerve leading from the spinal cord to a muscle in the hand

   6. ______ spinal cord and brain

4. The difference between motor nerve cells and sensory nerve cells is:

   a. ☐ motor nerve cells are part of the C.N.S.; sensory nerve cells are part of the P.N.S.

   b. ☐ motor nerve cells receive stimuli and conduct impulses towards the C.N.S.; sensory nerve cells cause muscles to respond

   c. ☐ motor nerve cells cause glands and muscles to respond; sensory nerve cells receive stimuli and conduct impulses towards the C.N.S.

   d. ☐ motor nerve cells cause glands and muscles to respond; sensory nerve cells receive stimuli, but do not conduct impulses

5. A synapse is:

   a. ☐ a motor nerve cell

   b. ☐ a sensory nerve cell

   c. ☐ the area of contact between two nerve cells

   d. ☐ the cell body of a spinal nerve cell

6. The synapse which is part of a simple reflex arc is:

   a. ☐ located in the spinal cord

   b. ☐ a nerve cell in the spinal cord

   c. ☐ a peripheral nerve cell

   d. ☐ a nerve cell in the brain only

7. A simple reflex arc, such as the one associated with the knee-jerk reflex:

   a. ☐ is composed of three or more motor nerves only

   b. ☐ involves at least one sensory nerve, one synapse, and one motor nerve

   c. ☐ is formed by at least three interconnected nerves of any variety

   d. ☐ involves only one sensory nerve and one synapse

Time completed ______________

WHEN YOU HAVE FINISHED THIS TEST, WRITE DOWN THE TIME. THEN TAKE THE LESSON TO YOUR INSTRUCTOR OR HIS ASSISTANT FOR CHECKING. WAIT UNTIL THE LESSON IS APPROVED BEFORE GOING ON TO THE NEXT LESSON.

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ADVANCED
GENERAL EDUCATION PROGRAM

A HIGH SCHOOL SELF-STUDY PROGRAM

THE GLANDULAR SYSTEM
LEVEL: III
UNIT: 3
LESSON: 10

U.S. DEPARTMENT OF LABOR
MANPOWER ADMINISTRATION, JOB CORPS
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1.

PREVIEW FRAME

In previous lessons you learned about various systems within the human organism. The next lesson is concerned with another system which controls and harmonizes the functions of many different organs in various systems. You will learn not only how these varied functions are regulated, but also how improper regulation leads to bodily disorders.

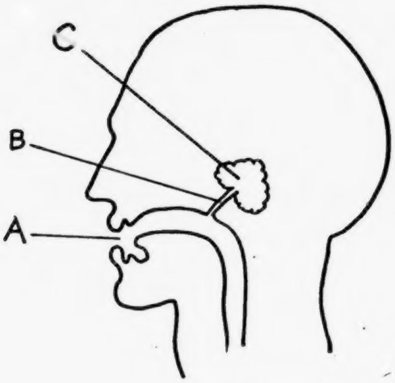
NO RESPONSE REQUIRED

GO ON TO THE NEXT FRAME

2.

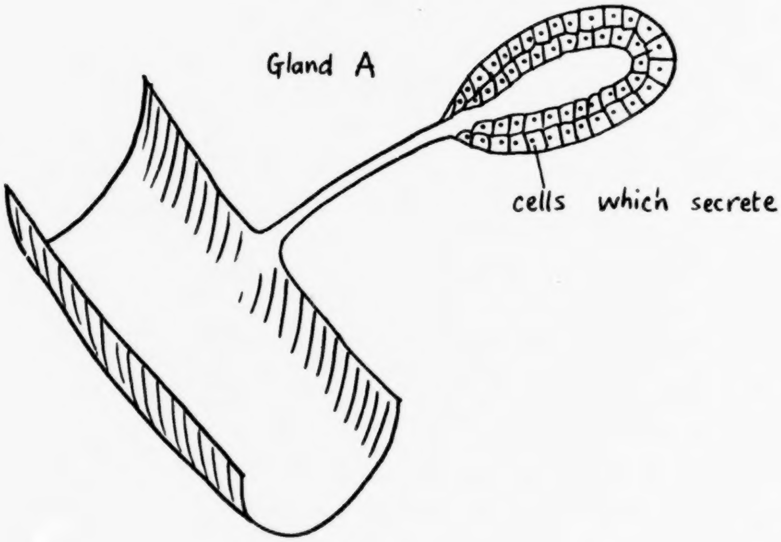
You recall that glands are organs which secrete chemical compounds, usually in fluid form. Sometimes these glands have tubes which carry the secretion to the place where it functions. Such a tube is called a duct.

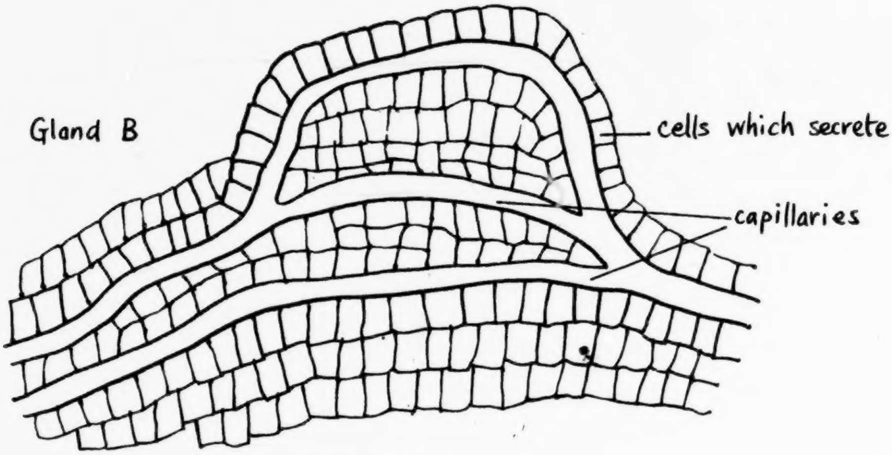
LOCATE the gland, the duct, and the organ where the secretions act in the diagram below, by writing one letter in each blank:



_____ duct	B
_____ glands	C
_____ organ where secretion acts	A

PANEL 1


Gland A
cells which secrete


Gland B
cells which secrete
capillaries

3.	
MATCH the terms to their descriptions by writing one letter in each blank:	
A. duct B. gland	
_____ Structure which carries secretions from one place to another.	A
_____ Structure which produces secretions.	B
4.	
REFER TO PANEL 1	
Some glands have ducts, others do not. Those which do not have ducts pass their secretions into the circulatory system. Those which do have ducts pass their secretions through the duct directly to the place where the secretions work.	
In Panel 1, the gland which does not have a duct is gland: ☐ A ☐ B	B
The secretions of gland B are carried from the gland by the: ☐ blood ☐ duct ☐ saliva	blood

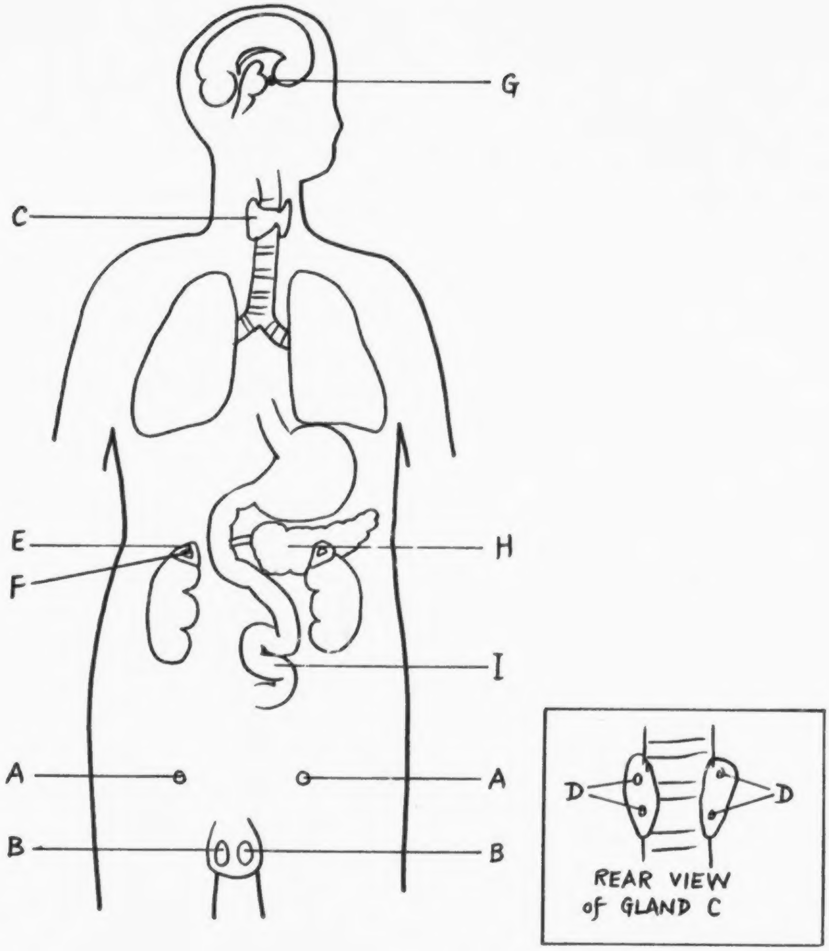
5.	
REFER TO PANEL 1	
The glands with ducts are called duct glands. The glands without ducts are called ductless glands, or endocrine* glands.	
The duct gland in Panel 1 is gland:	
☐ A ☐ B	A
Blood carries secretions from which glands?	
☐ duct glands ☐ endocrine glands	endocrine glands
Ductless glands:	
☐ have capillaries running through them ☐ do not have capillaries running through them	have capillaries running . . .
*Endocrine, Greek for separate ends, refers to the ends being separated for the capillaries.	
6.	
REFER TO PANEL 1	
The circulatory system can carry substances to any part of the body.	
The secretions of which type of gland are able to act in a part of the body relatively distant from the secreting gland?	
☐ duct glands ☐ endocrine glands	endocrine glands
Endocrine glands:	
☐ have ducts ☐ do not have ducts	do not have ducts

7.	
REFER TO PANEL 1	
One of the two types of glands, together with the secretions of the glands of this type, make up a separate system in the body, called the endocrine system.	
Evidently, the endocrine system consists of the glands and secretions illustrated in the panel by gland:	
☐ A ☐ B	B
Secretions of the glands in the endocrine system are:	
☐ able to act farther from the secreting gland than can secretions of the other type of gland	able to act farther from the . . .
☐ unable to act as distantly from the secreting gland as can secretions of the other type of gland	
Secretions of the endocrine system:	
☐ travel through ducts ☐ travel through the blood	travel through the blood
8.	
DO NOT REFER TO THE PANEL	
The endocrine system consists of:	
☐ duct glands and their secretions ☐ ductless glands and their secretions	ductless glands. . .
You can remember that endocrine glands regulate body functions from this sentence:	
"The end of crime is regulation."	

9. The secretions of duct glands perform some activity in a specific organ. For example, the saliva secreted by the salivary glands helps to digest carbohydrates in the mouth and the stomach. The secretions of ductless glands control or influence the activities of other organs in the endocrine system or other systems. Secretion A regulates the rate at which the liver stores or releases glucose. Secretion B breaks down fats in the small intestine. Secretion A comes from a: ☐ duct gland ☐ ductless gland Secretion B comes from a: ☐ duct gland ☐ ductless gland	ductless gland duct gland
10. MATCH the following by writing one letter in each blank: A. Secretion of duct gland B. Secretion of endocrine gland _____ substance that acts within an organ, into which it is secreted _____ substance that flows through the blood stream to control the activities of organs	A B

11.	
The secretions of most glands in the endocrine system are called hormones.	
Hormones:	
☐ carry on a special activity, such as digestion, within the organ into which they are secreted through ducts	
☐ control and coordinate the activities of one or more organs which they reach through the blood stream	control and coordinate the . . .
In general, hormones:	
☐ must act in a nearby organ	
☐ may act in a distant organ	may act in a distant organ
12.	
Hormones are secreted by:	
☐ duct glands	
☐ ductless glands	ductless glands

PANEL 2


G
C
E
F
H
I
A
A
B
B
D
D
REAR VIEW
of GLAND C

13.	
REFER TO PANEL 2	
A hormone which regulates the rate of oxidation in the body's cells is secreted by the gland marked C. A hormone which regulates the amount of calcium in the blood is secreted by the four glands marked D.	
Judging from the panel, which of the following is/are true?	
☐ The gland whose secretion regulates oxidation is located near the trachea.	. . . regulates oxidation . . . .
☐ The glands whose secretion regulates blood calcium are located near the trachea.	. . . regulates blood . . . .
☐ The gland regulating oxidation is located in the glands whose secretion regulates blood calcium.	
☐ The glands regulating blood calcium are located in the gland whose secretion regulates oxidation.	. . . regulating blood . . . .
The calcium content of the blood is controlled by a hormone secreted by:	
☐ a single gland	
☐ a gland with two parts	
☐ two glands	
☐ four glands	four glands

14.

DO NOT REFER TO THE PANEL

COMPLETE the following table by checking the appropriate boxes:

	Duct gland	Ductless glands	Duct gland	Ductless glands
belong to the endocrine system	☐	☐	☐	☒
can only affect nearby organs	☐	☐	☒	☐
generally can affect organs distant from the secreting gland	☐	☐	☐	☒
secrete hormones (in most cases)	☐	☐	☐	☒
secrete through ducts to the place of activity	☐	☐	☒	☐

15.

PREVIEW FRAME

You now know that the regulatory system which helps harmonize the body's activities is called the endocrine system, and consists of the ductless glands and their secretions.

The remainder of this lesson will teach you about the most important glands and secretions of the endocrine system, and how they affect the different systems of the body. You will learn about some of the diseases which may arise due to too much or too little of these regulatory secretions.

NO RESPONSE REQUIRED

GO ON TO THE NEXT FRAME

16.	
REFER TO PANEL 2	
The gland C is called the thyroid gland.* It secretes thyroxin. The glands marked D are called the parathyroid glands.** They secrete parathormone.	
The hormone regulating the rate of oxidation in cells is:	
☐ parathormone	
☐ thyroxin	thyroxin
The amount of calcium in the blood is controlled by the:	
☐ parathyroid glands	parathyroid glands
☐ thyroid gland	
Which of the following is true?	
☐ The thyroid gland is located in the parathyroid glands.	
☐ The parathyroid glands are located in the thyroid gland.	The parathyroid glands . . . .
*Flattened out, this gland reminded the Greeks of their battle shield, the thyreos.	
**You already have learned that para- means alongside.	
17.	
REFER TO PANEL 1	
The rate that oxidation occurs in the cells affects physical and mental growth. You would therefore expect physical and mental growth to be influenced by the hormone:	
☐ parathormone	
☐ thyroxin	thyroxin
Growth is thus associated with the:	
☐ parathyroid glands	
☐ thyroid gland	thyroid gland

18.

DO NOT REFER TO THE PANEL

COMPLETE the table by checking the appropriate boxes.

	thyroid gland	parathyroid glands	thyroid gland	parathyroid glands
located near the trachea	☐	☐	☒	☒
secretion affects physical and mental growth	☐	☐	☒	☐
secretion regulates amount of calcium in the blood	☐	☐	☐	☒
secretion regulates rate of oxidation in body cells	☐	☐	☒	☐
secrete(s) parathormone	☐	☐	☐	☒
secrete(s) thyroxin	☐	☐	☒	☐

19.

About 65% of thyroxin consists of the chemical element iodine.

You would expect to find large quantities of iodine in a hormone which:

- ☐ affects growth
- ☐ regulates blood calcium
- ☐ regulates oxidation

You would also not be surprised to find iodine in the:

- ☐ parathyroid glands
- ☐ thyroid gland

The secretion of the thyroid gland:

- ☐ has no iodine
- ☐ is less than half iodine
- ☐ is more than half iodine
- ☐ is entirely iodine

affects growth

regulates oxidation

thyroid gland

is more than half iodine

20. Iodine is: ☐ the main component of parathormone ☐ a minor component of parathormone ☐ the main component of thyroxin ☐ a minor component of thyroxin	the main component of thyroxin
21. When a gland produces more of its secretion than it should, we say that it oversecretes. When it does not produce enough, we say that it undersecretes. Your skin contains sweat glands which allow you to perspire. If you did not perspire on a very hot day, you would suspect that your sweat glands were: ☐ oversecreting ☐ undersecreting Tears are produced by tear glands near the eye. If someone cried all the time you would say that his tear glands were: ☐ oversecreting ☐ undersecreting	undersecreting oversecreting
22. MATCH the terms to their definitions by writing one letter in each blank: A. oversecretion B. undersecretion _____ When a gland produces too little of its secretion. _____ When a gland produces too much of its secretion.	B A

23.	
Too much thyroxin speeds up oxidation. This causes a person to be restless and nervous and to lose weight. Too little thyroxin leads to sluggishness, weakness, and gaining weight.	
Too much parathormone results in too much calcium in the blood, which weakens the bones. Too little parathormone results in violent muscular spasms and severe irritability.	
If someone is nervous and underweight, you might suspect that his:	
☐ parathyroid glands are oversecreting	
☐ parathyroid glands are undersecreting	
☐ thyroid glands are oversecreting	thyroid glands are oversecreting
☐ thyroid glands are undersecreting	
If a person has weak bones, you might suspect that his:	
☐ parathyroid glands are oversecreting	parathyroid glands are over- . . .
☐ parathyroid glands are undersecreting	
☐ thyroid glands are oversecreting	
☐ thyroid glands are undersecreting	
If the thyroid gland secretes less thyroxin, you would expect the person to:	
☐ gain weight	gain weight
☐ lose weight	
☐ have muscular spasms	
☐ become restless	
☐ become sluggish	become sluggish
☐ have weakened bones	

24.	
MATCH the following by writing one letter in each blank:	
A. too much thyroxin	
B. too little thyroxin	
C. too much parathormone	
D. too little parathormone	
_____ loss of weight, restlessness, nervousness	A
_____ muscular spasms, extreme irritability	D
_____ overweight, sluggishness	B
_____ weak bones	C
25.	
When the thyroid gland oversecretes, the result is:	
☐ loss of weight, restlessness, nervousness	loss of weight, . . .
☐ muscular spasms, extreme irritability	
☐ overweight, sluggishness	
☐ weak bones	
When the parathyroid glands oversecrete, the result is:	
☐ loss of weight, restlessness, nervousness	
☐ muscular spasms, extreme irritability	
☐ overweight, sluggishness	
☐ weak bones	weak bones
Overweight and sluggishness are likely to be caused by:	
☐ too little parathormone	
☐ too little thyroxin	too little thyroxin
☐ too much parathormone	
☐ too much thyroxin	

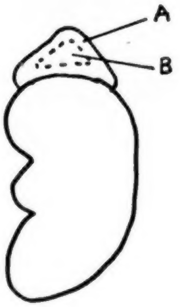
26.

COMPLETE the table by checking the appropriate boxes:

	thyroid gland	para-thyroid glands	thyroid gland	para-thyroid glands
secrete(s) parathormone	☐	☐	☐	☒
secrete(s) thyroxin	☐	☐	☒	☐
affects amount of calcium in blood	☐	☐	☐	☒
affects oxidation rate in cells	☐	☐	☒	☐
influences physical and mental growth	☐	☐	☒	☐
secretion largely consists of iodine	☐	☐	☒	☐
located near trachea	☐	☐	☒	☒
oversecretion causes weak bones	☐	☐	☐	☒
oversecretion causes loss of weight, restlessness, nervousness	☐	☐	☒	☐
undersecretion causes muscular spasms and extreme irritability	☐	☐	☐	☒
undersecretion causes sluggishness and gain in weight	☐	☐	☒	☐

27.	
REFER AGAIN TO PANEL 2	
The panel shows a pair of glands which sit on top of the two kidneys and which have an inner part and an outer part.	
The inner part is indicated by the letter _____.	F
The outer part is indicated by the letter _____.	E
A hormone which increases the rate of breathing and of the heartbeat is secreted by the part of the gland marked F. A group of hormones which regulate the amount of sodium and potassium in the blood is secreted by the part of the gland marked E.	
The source of the hormone which speeds up breathing and heartbeat lies:	
☐ inside the source of hormones regulating sodium and potassium in the blood	inside the source of . . .
☐ around the outside of the source of hormones regulating sodium and potassium in the blood	

28.



MATCH the structures above to their functions by writing one letter in each blank below:

_____ secretion which regulates the amount of sodium and potassium in the blood

_____ secretion which speeds up breathing and the heartbeat

A

B

29. REFER TO PANEL 2	
The gland indicated by letters E and F is called the adrenal gland. From the panel you can see that there is/are: ☐ one adrenal gland ☐ two adrenal glands	two adrenal glands
The adrenal glands are located on top of the: ☐ esophagus ☐ kidneys ☐ lungs	kidneys
The inner part of the adrenal gland is called the adrenal medulla. It secretes adrenalin. The outer part is called the adrenal cortex. It secretes a group of hormones called adrenal cortical hormones.	
The hormone(s) which speed(s) up heartbeat and breathing is/are: ☐ adrenalin ☐ the adrenal cortical hormones	adrenalin
The amount of sodium and potassium in the blood is regulated by the: ☐ adrenal cortex ☐ adrenal medulla	adrenal cortex

30.	
The hormone which increases the rate of breathing and the heartbeat also performs other functions: but all its activities have this in common: they prepare the body for the increased activity needed to meet an emergency.	
Which of the following increases its secretion of hormones in order to help the body react to a dangerous situation?	
☐ adrenal cortex ☐ adrenal medulla	adrenal medulla
An emergency situation will stimulate to secretion the:	
☐ inner part of the adrenal glands ☐ outer part of the adrenal glands	inner part of the adrenal glands
31.	
Sodium and potassium are substances used by the nerves in the process of conducting nerve impulses.	
You know that the amount of these two elements in the blood is regulated by:	
☐ adrenalin ☐ the adrenal cortical hormones	the adrenal cortical hormones
You would therefore expect the conduction of nerve impulses to be influenced by the secretions of the adrenal:	
☐ cortex ☐ medulla	cortex
This part of the adrenal gland therefore has direct effect on the:	
☐ digestive system ☐ nervous system ☐ respiratory system	nervous system

32.

DO NOT REFER TO THE PANEL

COMPLETE the table below by checking the appropriate boxes:

	adrenal cortex	adrenal medulla	adrenal cortex	adrenal medulla
inner part of adrenal gland	☐	☐	☐	☒
outer part of adrenal gland	☐	☐	☒	☐
located on top of the kidneys	☐	☐	☒	☒
secretes adrenalin	☐	☐	☐	☒
secretes adrenal cortical hormones	☐	☐	☒	☐
secretion speeds up breathing and heartbeat rates	☐	☐	☐	☒
secretion regulates the amount of sodium and potassium in the blood	☐	☐	☒	☐
secretion prepares the body for an emergency	☐	☐	☐	☒
secretion influences conduction in the nervous system	☐	☐	☒	☐

33.	
REFER AGAIN TO PANEL 2	
An endocrine gland which controls the secretions of many other endocrine glands is attached to the lower surface of the brain. In the panel it is indicated by the letter _____.	G
This gland produces hormones which stimulate the secretion of thyroxin and of adrenal cortical hormones.	
Thus, gland G controls the activity of structures _____ and _____. (GIVE LETTERS.)	C, E (any order)
Indirectly, then, this gland under the brain affects the:	
☐ amount of calcium in the blood	
☐ amount of sodium and potassium in the blood	amount of sodium and . . .
☐ breathing and heartbeat rates	
☐ oxidation rate in cells	oxidation rate in cells

34.	
REFER TO PANEL 2	
Gland G is called the pituitary gland. We will consider only three of the many hormones it secretes: thyrotrophin, which stimulates the thyroid gland; the growth hormone, which regulates the growth of bones; and ACTH, which affects the secretion of the adrenal cortex.	
The secretion of thyroxin is promoted by: ☐ ACTH ☐ the growth hormone ☐ thyrotrophin	thyrotrophin
The secretion of adrenal cortical hormones is influenced by: ☐ ACTH ☐ the growth hormone ☐ thyrotrophin	ACTH
A child's size at a given age is affected by: ☐ ACTH ☐ the growth hormone ☐ thyrotrophin	the growth hormone
ACTH affects the activity of the: ☐ adrenal cortex ☐ adrenal medulla ☐ pituitary gland	adrenal cortex

35.

FOOTNOTE FRAME

ACTH stands for adrenocorticotrophic hormone; this means, "a hormone which nourishes the adrenal cortex."

The thyroid gland and the adrenal cortex are not the only endocrine glands stimulated by pituitary hormones -- actually most of the ductless glands are affected by the pituitary gland. It is the chief controlling gland in the endocrine system.

The hormones secreted by the pituitary have functions other than those regulating endocrine glands. In addition to the growth hormone there is a pituitary hormone which stimulates the mammary glands to produce milk.

NO RESPONSE REQUIRED

GO ON TO THE NEXT FRAME

36.

REFER TO PANEL 2

LOCATE the sources of the hormones listed below by writing one letter in each blank:

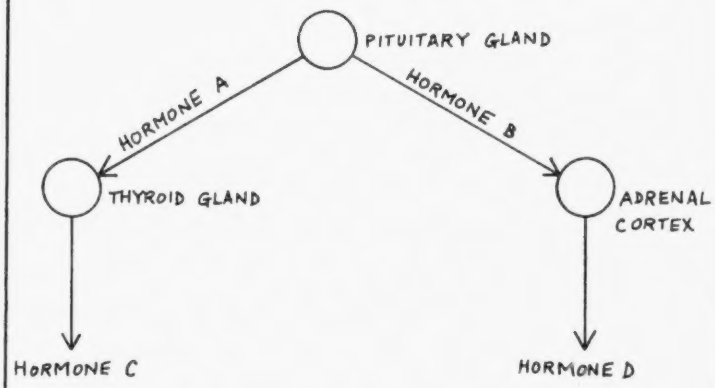
A. secreted near the trachea

B. secreted above the kidneys

C. secreted just under the brain

_____	ACTH	C
_____	adrenalin	B
_____	adrenal cortical hormones	B
_____	growth hormone	C
_____	parathormone	A
_____	thyrotrophin	C
_____	thyroxin	A

37.


PITUITARY GLAND
HORMONE A
HORMONE B
THYROID GLAND
ADRENAL CORTEX
HORMONE C
HORMONE D

LOCATE the terms below on the above diagram by writing one letter in each blank:

______ ACTH	B
______ cortical hormones	D
______ thyrotrophin	A
______ thyroxin	C

38.

As a child matures, the growth hormone affects the rate of growth of his bones. A greater amount of growth hormone increases the growth rate.

If the growth hormone is undersecreted during childhood, the mature man might be a:

☐ dwarf	dwarf
☐ giant	

If the growth hormone is oversecreted during childhood, the mature man might be a:

☐ dwarf	
☐ giant	giant

39. The condition of being a dwarf is called dwarfism. The condition of being a giant is called gigantism. Both conditions are caused by abnormalities in the secretion of:	
☐ ACTH ☐ the growth hormone ☐ thyrotrophin	the growth hormone
This secretion comes from the:	
☐ adrenal cortex ☐ pituitary gland ☐ thyroid gland	pituitary gland
MATCH the following by writing one letter in each blank:	
A. dwarfism B. gigantism	
_____ caused by undersecretion of the growth hormone	A
_____ caused by oversecretion of the growth hormone	B

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40.	
DO NOT REFER TO THE PANEL	
The pituitary gland secretes:	
☐ ACTH	ACTH
☐ adrenalin	
☐ adrenal cortical hormones	
☐ the growth hormone	the growth hormone
☐ thyrotrophin	thyrotrophin
☐ thyroxin	
The secretion of the thyroid gland is regulated by:	
☐ ACTH	
☐ the growth hormone	
☐ thyrotrophin	thyrotrophin
☐ thyroxin	
The secretion of the adrenal cortex is regulated by:	
☐ ACTH	ACTH
☐ the growth hormone	
☐ thyrotrophin	
MATCH the following by writing one letter in each blank:	
A. dwarfism	
B. gigantism	
_____ caused by oversecretion of the growth hormone	B
_____ caused by undersecretion of the growth hormone	A
The growth hormone is secreted by a gland that is:	
☐ above the kidneys	
☐ beneath the brain	beneath the brain
☐ near the trachea	

41.

DO NOT REFER TO THE PANEL

MATCH the endocrine glands to their secretions by writing one letter in each blank:

A. adrenal cortex
B. adrenal medulla
C. parathyroid gland
D. pituitary gland
E. thyroid gland

_____ ACTH	D
_____ adrenalin	B
_____ adrenal cortical hormones	A
_____ growth hormone	D
_____ parathormone	C
_____ thyrotrophin	D
_____ thyroxin	E

42.

DO NOT REFER TO THE PANEL

MATCH the hormones to their functions by writing one letter in each blank:

A. ACTH
B. adrenalin
C. adrenal cortical hormones
D. growth hormone
E. parathormone
F. thyrotrophin
G. thyroxin

_____ increases rate of heartbeat and breathing	B
_____ regulates amount of calcium in the blood	E
_____ regulates amount of sodium and potassium in the blood	C
_____ regulates bone growth	D
_____ regulates rate of oxidation in body cells	G
_____ regulates secretion of cortical hormones	A
_____ regulates secretion of thyroxin	F

43.	
REFER AGAIN TO PANEL 2	
From a previous lesson you recall that the pancreas produces a secretions called pancreatic juice which passes through the common bile duct into the small intestine.	
With respect to this secretion, the pancreas: ☐ is a part of the endocrine system ☐ is not a part of the endocrine system	is not a part of the . . .
Small groups of cells within the tissue of the pancreas act as ductless glands and secrete directly into the blood.	
The location of such groups of cells is indicated in the panel by the letter ______.	H
These glands control the passage of glucose into liver cells and other body cells.	
The lining of the small intestine (1 in the panel) also acts as a ductless gland, secreting a hormone that stimulates the pancreas to produce pancreatic juice.	
The passage of glucose into liver cells and other body cells is regulated by a hormone produced: ☐ in the lining of the small intestine ☐ inside the pancreas	inside the pancreas
Pancreatic juice flows to the small intestine when a hormone is secreted by: ☐ the lining of the small intestine ☐ the pancreas	the lining of the small intestine

44.	
REFER TO PANEL 2	
The letter H in the panel refers to groups of cells within the pancreas which act as endocrine glands. They are called the Islands of Langerhans, and they secrete the hormone insulin. The letter I in the panel refers to the lining of the small intestine, which produces the hormone called secretin.	
The hormone regulating the passage of glucose into the liver's cells and other body cells is: ☐ insulin ☐ secretin ☐ thyrotrophin	insulin
The amount of pancreatic juice is regulated by a hormone secreted by the: ☐ Islands of Langerhans ☐ lining of the small intestine ☐ pancreas	lining of the small intestine
The Islands of Langerhans are located in the: ☐ lining of the small intestine ☐ pancreas	pancreas

45.

REFER TO PANEL 2

COMPLETE the table by checking the appropriate boxes:

	insulin	secretion	insulin	secretion
secreted by groups of cells within the pancreas	☐	☐	☒	☐
secreted by the lining of the small intestine	☐	☐	☐	☒
causes pancreatic juice to be secreted	☐	☐	☐	☒
regulates the amount of glucose in liver cells and other body cells	☐	☐	☒	☐
secreted by the Islands of Langerhans	☐	☐	☒	☐

46.

The hormone insulin,controls the amount of glucose in the blood. If there is not enough insulin in the blood the amount of glucose in the blood increases. If the level of glucose in the blood increases beyond a certain point, it causes a complex chain of chemical reactions which lead to disease, and even death.

This disease is the result of:

- ☐ oversecretion by the lining of the small intestine
- ☐ oversecretion by the Islands of Langerhans
- ☐ undersecretion by the Islands of Langerhans
- ☐ undersecretion by the lining of the small intestine

under- . . . Langerhans

47.

The dangerous disease brought about by too much glucose in the blood is called diabetes.

Diabetes is caused by:

- ☐ undersecretion of insulin
- ☐ oversecretion of insulin

undersecretion of insulin

Diabetes occurs when there is a malfunction of the:

- ☐ adrenal cortex
- ☐ Islands of Langerhans
- ☐ lining of the small intestine
- ☐ thyroid gland

Islands of Langerhans

48.

DO NOT REFER TO THE PANEL

COMPLETE the table below by checking the appropriate boxes:

	insulin	secretin	insulin	secretin
secreted by the lining of the small intestine	☐	☐	☐	☒
secreted by the Islands of Langerhans	☐	☐	☒	☐
regulates the passage of glucose from the blood into liver cells and other body cells	☐	☐	☒	☐
causes pancreatic juice to be secreted	☐	☐	☐	☒
undersecretion causes diabetes	☐	☐	☒	☐
secreted within the pancreas	☐	☐	☒	☐

49.	
REFER AGAIN TO PANEL 2	
The diagram includes two pairs of sex glands, marked A and B for the sake of illustration. Any normal human being, however, has only one pair of sex glands.	
The two female glands lie higher than the two male glands. The female glands are those marked by the letter _____.	A
A normal human has: ☐ 1 sex gland ☐ 2 sex glands ☐ 4 sex glands	2 sex glands
50.	
REFER TO PANEL 2	
The sex glands are also called the gonads. The female gonads are called ovaries; the male gonads are called testes.	
The ovaries in the panel are indicated by the letter _____.	A
The testes are indicated by the letter _____.	B
In a previous lesson you learned that the gonads produce reproductive cells. The gonads also secrete hormones which produce the outward differences between a man and a woman.	
The hormones causing a feminine, high-pitched, musical voice, are secreted by the: ☐ ovaries ☐ testes	ovaries
The hormones causing a beard to grow on the face are secreted by the: ☐ ovaries ☐ testes	testes

51.	
The male and female reproductive organs are themselves the primary sexual characteristics.	
The other outward differences between a man and a woman, such as voice pitch and facial hair, are called the secondary sexual characteristics.	
The secondary sexual characteristics are affected by which product of the gonads? ☐ hormones ☐ reproductive cells	hormones
A womanly body structure is a: ☐ primary sexual characteristic ☐ secondary sexual characteristic	secondary sexual characteristic
52.	
The ovaries secrete the hormones called estrogens. The testes secrete the hormones called androgens.	
A low-pitched, gruff voice would be caused by: ☐ androgens ☐ estrogens	androgens
A feminine body shape is caused by: ☐ androgens ☐ estrogens	estrogens
Androgens and estrogens affect: ☐ the primary sexual characteristics ☐ the secondary sexual characteristics	the secondary sexual . . .

53.

DO NOT REFER TO THE PANEL

COMPLETE the table by checking the appropriate boxes:

	androgens	estrogens	androgens	estrogens
secreted by ovaries	☐	☐	☐	☒
secreted by gonads	☐	☐	☒	☒
secreted by testes	☐	☐	☒	☐
regulates development of secondary sexual characteristics	☐	☐	☒	☒
cause secondary female characteristics to develop	☐	☐	☐	☒
cause secondary male characteristics to develop	☐	☐	☒	☐

54.

REFER AGAIN TO PANEL 2

MATCH the structure on the panel with the gland names and hormone(s) secreted by writing one letter in each blank:

_____ adrenal cortex	E
_____ adrenal medulla	F
_____ Islands of Langerhans	H
_____ lining of small intestine	I
_____ ovaries	A
_____ parathyroid glands	D
_____ pituitary gland	G
_____ testes	B
_____ thyroid gland	C
_____ ACTH	G

55.

REFER AGAIN TO PANEL 2

MATCH the structure on the panel with the gland names and hormone(s) secreted by writing one letter in each blank:

_____ adrenalin	F
_____ androgen	B
_____ cortical hormones	E
_____ growth hormone	G
_____ insulin	H
_____ estrogen	A
_____ parathormone	D
_____ secretin	I
_____ thyrotrophin	G
_____ thyroxin	C

56.

TERMINAL FRAME

DO NOT REFER TO THE PANEL

MATCH the hormones to their functions by writing one or more letters in each blank:

A. ACTH
B. adrenalin
C. androgen
D. adrenal cortical hormones
E. growth hormone
F. estrogen
G. insulin
H. parathormone
I. secretin
J. thyrotrophin
K. thyroxin

_____ regulates rate of oxidation in the body cells	K
_____ regulates amount of calcium in the blood	H
_____ increases heartbeat and breathing rate	B
_____ regulates amount of sodium and potassium in the blood	D
_____ regulates bone growth	E
_____ regulates secretion of thyroxin	J
_____ regulates secretion of cortical hormones	A
_____ regulates passage of glucose into liver cells and other body cells	G
_____ stimulates secretion of pancreatic juice	I
_____ regulates development of secondary sexual characteristics	C, F

Time completed ________________

YOU HAVE NOW FINISHED THE FIRST PART OF THIS LESSON. WRITE DOWN THE TIME. THEN, AFTER YOU HAVE REVIEWED THE MAIN IDEAS IN THE FOLLOWING SUMMARY, TAKE THE MASTERY TEST AT THE END OF THE BOOKLET.

DUCT glands:	the glands whose secretions are carried to their place of activity by ducts, or tubes. Example: salivary glands
DUCTLESS or ENDOCRINE glands	the glands whose secretions are carried by the blood stream to their place of activity.
HORMONES	name given to the secretions of the endocrine glands.
	See attached list.

NOTE: Skip three(3) pages and take the Mastery Test.

GLAND	LOCATION	SECRETION	ACTIVITY	OVERSECRETION	UNDERSECRETION
thyroid	near the trachea	thyroxin	regulates the rate of oxidation in the body's cells	person is restless and nervous and tends to lose weight	person reacts slowly and tends to gain weight
parathyroid	on the thyroid	parathormone	regulates the amount of calcium in the blood	weakened bone structure	violent muscular spasms and severe irritability
adrenal medulla	on top of kidneys	adrenalin	prepares the body for increased activity	very fast heartbeat and breathing rate	
adrenal cortex		adrenal cortical hormones	regulates the amount of sodium and potassium in the blood which have a direct effect on the conduction of nerve impulses		
pituitary	under the brain	thyrotropin	stimulates the thyroid gland		
		growth hormone	regulates the growth of bones	gigantism	dwarfism
		ACTH	affects the secretion of the adrenal cortex		
islands of langerhans	in the pancreas	insulin	regulates the passage of glucose from the blood into liver cells and other body cells.		diabetes

GLAND	LOCATION	SECRETION	ACTIVITY	OVERSECRETION	UNDERSECRETION
glands in the lining of the small intestine		secretin	causes pancreatic juice to be secreted		
ovaries testes		estrogens androgens	development of secondary sexual characteristics		

MASTERY TEST

Time started ____________

1. Saliva is (CHECK one or more phases):

   a. ☐ a secretion
   b. ☐ a hormone
   c. ☐ produced by a duct gland
   d. ☐ produced by a ductless gland

2. Secretions of the endocrine system reach their place of activity:

   a. ☐ through ducts
   b. ☐ through the blood stream
   c. ☐ by always passing through other organs first
   d. ☐ by none of the above

3. The secretion of thyroxin is stimulated by:

   a. ☐ parathormone
   b. ☐ estrogen
   c. ☐ thyrotrophin
   d. ☐ secretin

4. CHECK the hormone(s) that is/are secreted by the gland found on top of the kidneys:

   a. ☐ thyroxin
   b. ☐ thyrotrophin
   c. ☐ adrenal cortical hormones
   d. ☐ adrenalin

5. Which gland listed below secretes substances that affect the secretions of many other glands in the endocrine system?

   a. ☐ pituitary
   b. ☐ thyroid
   c. ☐ small intestine
   d. ☐ parathyroid

6. The passage of glucose to liver cells and other cells is affected by:

   a. ☐ insulin
   b. ☐ androgen
   c. ☐ pancreatic juice
   d. ☐ secretin

7. Secondary sexual characteristics are primarily affected by secretions of:

   a. ☐ the gonads
   b. ☐ the parathyroids
   c. ☐ the pancreas
   d. ☐ the pituitary

Time completed ______________

WHEN YOU HAVE FINISHED THIS TEST, WRITE DOWN THE TIME. THEN TAKE THE LESSON TO YOUR INSTRUCTOR OR HIS ASSISTANT FOR CHECKING. WAIT UNTIL THE LESSON IS APPROVED BEFORE GOING ON TO THE NEXT LESSON.

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